TUGAS AKHIR

MODIFIKASI STRUKTUR TOWER BAJA 80M PADA PROYEK PEMBANGUNAN RBS CDNA PT. MOBOLE 8 TELECOM DENGAN 3 (TIGA) ALTERNATIF

OLEH : TRI WINARTO

NRP 3102.109.515

DOSEN PEMBIMBING

Ir. R. SOEWARDOJO, MSc

PROGRAM SARJANA (S-1)
JURUSAN TEKNIK SIPIL
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2004

TUGAS AKHIR

MODIFIKASI STRUKTUR TOWER BAJA 80M PADA PROYEK PEMBANGUNAN RBS CDNA PT. MOBOLE 8 TELECOM DENGAN 3 (TIGA) ALTERNATIF

SURABAYA, JUNI 2004

MENGETAHUI/MENYETUJUI

DOSEN PEMBIMBING

Ir. R. SOEWARDOJO, MSc

NIP 130.520.307

PROGRAM SARJANA (S-1)
JURUSAN TEKNIK SIPIL
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2004

MODIFIKASI STRUKTUR TOWER BAJA 80 M PADA PROYEK PEMBANGUNAN RBS CDMA PT. MOBILE 8 TELECOM DENGAN 3 (TIGA) ALTERNATIF

Oleh :Tri Winarto
NRP 3102.109.515

Abstrak

Salah satu alat telekomunikasi yang semakin banyak penggunanya adalah telepon seluler. PT. Mobile 8 Telecom sebagai salah satu operator telepon seluler membangun fasilitas untuk memperluas jangkauannya, yaitu dengan membangun tower rangka baja yang digunakan sebagai pemancar. Dalam Tugas Akhir ini akan dilakukan modifikasi bentuk tower dengan ketinggian 80 meter sebanyak 3 (tiga) alternatif dengan menggunakan TIA/EIA Standard 1996, UBC 1997 (Uniform Building Code) dan konsep LRFD (Load and Resistence Faktor Design). Setelah dilakukan analisa struktur dengan SAP2000 dan dilakukan kontrol terhadap gaya – gaya yang terjadi, maka desain alternatif 1 mempunyai berat 27196 kg, berat desain alternatif 2 sebesar 25310 kg dan berat dari alternatif 3 adalah 28755 kg. Dengan demikian alternatif 2 adalah terpilih sebagai tower dengan berat paling ringan, selanjutnya dilakukan berhitungan sambungan dan perhitungan pondasi pada struktur tower alternatif 2 tersebut. Dari hasil perhitungan dapat digambarkan sebagai acuan dalam pelaksanaanya

Kata kunci : *steel, antenna, tower, telekomunikasi, seluler, modifikasi, beban*

KATA PENGANTAR

Puji syukur alhamdulillah atas segala rahmat dan nikmat Allah SWT, hanya karena-Nyalah hingga dapat menyelesaikan tugas akhir ini. Shalawat serta salam semoga tetap tercurah kepada Nabi Muhammad SAW serta para pengikut – pengikutnya yang senantiasa setia melaksanakan ajarannya.

Tugas akhir ini berjudul **"Modifikasi struktur tower baja 80 m pada proyek pembangunan RBS CDMA PT. Mobile 8 Telecom dengan 3 (tiga) alternatif "** . merupakan syarat menyelesaikan program studi jurusan Teknik Sipil Lintas Jalur Ekstensi ITS , serta dalam rangka mengaplikasikan ilmu yang telah diperoleh selama di bangku kuliah, khususnya dalam hal ini bidang studi konstruksi baja.

Bagi pembaca yang kemungkinan membuka laporan tugas akhir ini baik yang hanya membaca maupun mempelajari untuk sumber referensi kami ucapkan banyak terima kasih. Kami sadar dengan terbatasnya pengetahuan dan pengalaman dalam perencanaan struktur tower baja ini. Oleh karena itu saran dan kritik selalu kami terima demi kesempurnaan laporan tugas akhir ini.

Pada akhir prakata kami ingin mengucapkan terima kasih yang sebesar-besarnya kepada :

1. Bapak Ir. R. Soewardojo, MSc selaku dosen pembimbing
2. Ibu Dr.Ir. Ria Asih selaku dosen wali
3. Bapak dan Ibu dosen Teknik Sipil Lintas Jalur Ekstensi FTSP ITS.
4. Kedua orang tua yang kami cintai atas do'a restunya
5. Mbak Dian, Mbak Eni, Mas Tego, Mbak Yuyun, Mbak Yanti, Mbak Lia atas dukungannya.
6. Imam Mahmud, Udanto, Wahyu Eka, Mukminin dan teman-teman seperjuangan di kampus ITS
7. Bapak Arif Gunawan dan Bapak Dedy atas bantuannya.

Semoga laporan tugas akhir ini dapat bermanfaat dan memberikan konstribusi kepada kita semua, Amin.

Surabaya, Mei 2004

Penyusun

DAFTAR ISI

DAFTAR TABEL

DAFTAR GAMBAR

BAB I
PENDAHULUAN

BAB I
PENDAHULUAN

1.1. Latar Belakang

Salah satu kebutuhan manusia adalah kebutuhan dalam bidang informasi dan telekomunikasi. Di masa sekarang ini, teknologi di bidang informasi dan telekomonikasi semakin canggih dan mempermudah manusia untuk mendapatkan informasi dan dapat bertelekomunikasi dengan cepat tanpa dibatasi oleh ruang dan waktu.

Salah satu alat telekomunikasi yang semakin banyak penggunanya adalah telepon seluler. Untuk memenuhi dan melayani kebutuhan masyarakat tersebut, maka PT. Mobile 8 Telecom sebagai salah satu operator dari telepon seluler membangun fasilitas untuk memperluas jangkauannya yaitu dengan membangun tower yang digunakan sebagai pemancar.

Tower dirancang dengan konstruksi baja, yang merupakan salah satu dari bahan kontstruksi yang paling penting. Sifat–sifat yang terutama penting dalam penggunaan konstruksi adalah kekuatannya yang tinggi, dibandingkan dengan bahan lain yang tersedia. Baja juga mempunyai sifat ductile (kenyal), yaitu kesanggupan menerima perubahan bentuk yang besar tanpa mengalami kerusakan. Struktur tower baja tersebut didesain dengan konstruksi rangka baja. Konstruksi rangka baja mempunyai keistimewaan, yaitu dapat mencapai panjang atau ketinggian yang cukup besar akan mempunyai berat yang lebih ringan. Pada Tugas Akhir ini akan di coba untuk memodifikasi bentuk tower tipe SST 80 meter, sehingga mendapakan bobot struktur yang terkecil tanpa mengabaikan faktor keselamatan dan fungsi dari tower tersebut.

1.2. Permasalahan

Di dalam penulisan tugas akhir ini, hal-hal yang perlu diperhatikan adalah:

1. Bagaimana merencanakan struktur tower baja yang paling ekonomis dari beberapa variasi desain rangka dengan tinggi sama,yakni 80 m.

2. Bagaimana kontrol terhadap defleksi dan sway / goyangan dan twist/puntir yang terjadi akibat beban-beban lateral, agar struktur tower dapat berfungsi sebagai pemancar dengan hasil yang baik.
3. Bagaimana merencanakan sambungan profil struktur tower tersebut, agar antar profil tersebut dapat tersambung dengan kuat dan aman serta efisien.
4. Bagaimana merencanakan pondasi untuk menahan beban-beban yang terjadi dalam struktur tower baja tersebut.

1.3 Maksud dan Tujuan

Maksud penulisan tugas akhir ini adalah sebagai syarat untuk menyelesaikan program studi di jurusan Teknik Sipil, Fakultas Teknik Sipil dan Perencanaan ITS.

Adapun tujuan yang diharapkan dari perencanaan struktur tower ini adalah sebagai berikut:

1. Untuk merencanakan struktur tower baja yang kuat dan aman didalam menahan beban yang terjadi.
2. Bisa mendapatkan dimensi penampang yang kuat, ekonomis dan efisien.
3. Bisa merencanakan sambungan dan kebutuhan baut seminimal mungkin.
4. Dapat merencanakan struktur pondasi yang aman, untuk menahan beban-beban yang terjadi pada struktur.
5. Untuk menerapkan kegiatan perencanaan struktur baja, yang selama ini baru kami kenal melalui teori dari dalam kuliah.

1.4 Batasan Masalah

Pada penulisan tugas akhir ini dilakukan pembatasan ruang lingkup pembahasan, yaitu:

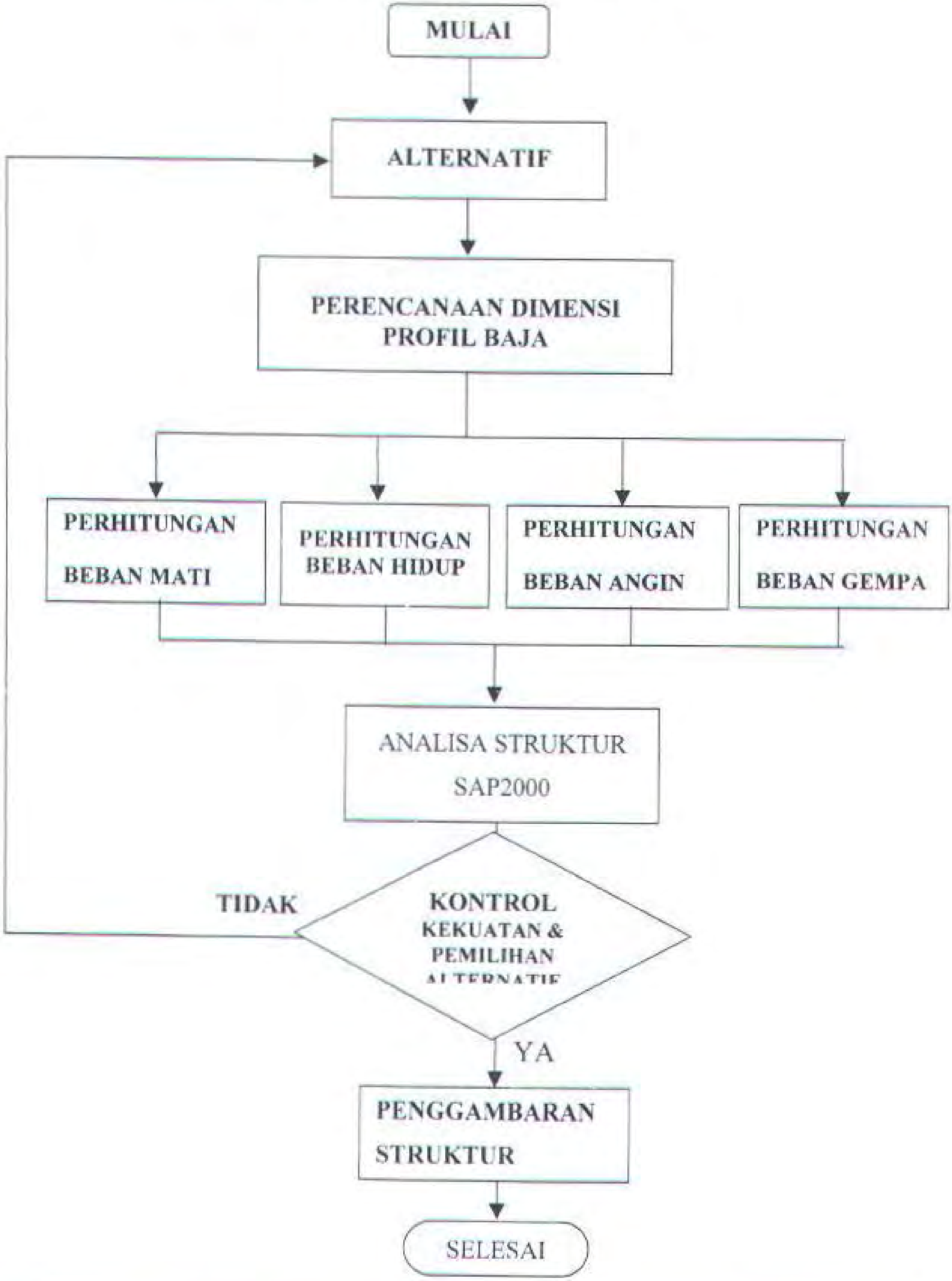
1. Modifikasi tower /struktur atas sebanyak 3 (tiga) alternatif)
2. Pemilihan alternatif berdasarkan bobot/berat tower yang terkecil
3. Perencanaan struktur bawah/pondasi berdasarkan alteratif yang terpilih
4. Pada tugas akhir ini tidak membahas fabrikasi dan pelaksaanaan di lapangan

1.5 Metodologi

Dalam penulisan tugas akhir ini direncanakan serangkaian tahapan kegiatan yang akan ditempuh, yaitu:

1. Pengumpulan data-data yang diperlukan.
2. Studi pustaka, yaitu mempelajari buku-buku yang berhubungan dengan perencanaan struktur tower baja.
3. Proses perhitungan struktur, meliputi:
   - menentukan beberapa alternatif desain struktur tower.
   - pembebanan struktur tower baja.
   - analisa struktur dengan menggunakan program SAP2000.
   - kontrol terhadap beban yang terjadi.
   - kontrol terhadap defleksi.
   - kontrol terhadap sway / goyangan.
   - Kontrol tehadap twist/puntir
   - pemilihan alternatif desain yang paling ekonomis.
   - perhitungan sambungan dari alternatif desain yang terpilih.
   - perhitungan struktur bawah.
4. Penggambaran struktur.
5. Penyusunan laporan tugas akhir.
6. Evaluasi.
7. Penjilidan laporan tugas akhir.

PROSEDUR PERENCANAAN



BAB II
DATA-DATA PERENCANAAN

BAB II

DATA – DATA PERENCANAAN

2.1. Data – Data Tower

1. Tinggi tower : 80 m
2. Lebar dasar tower : 8.9 m
3. Lebar puncak tower : 1.3 m
4. Lokasi proyek : Jl. Ikan Duyung-Bangil, Pasuruan

2.2. Data Tanah

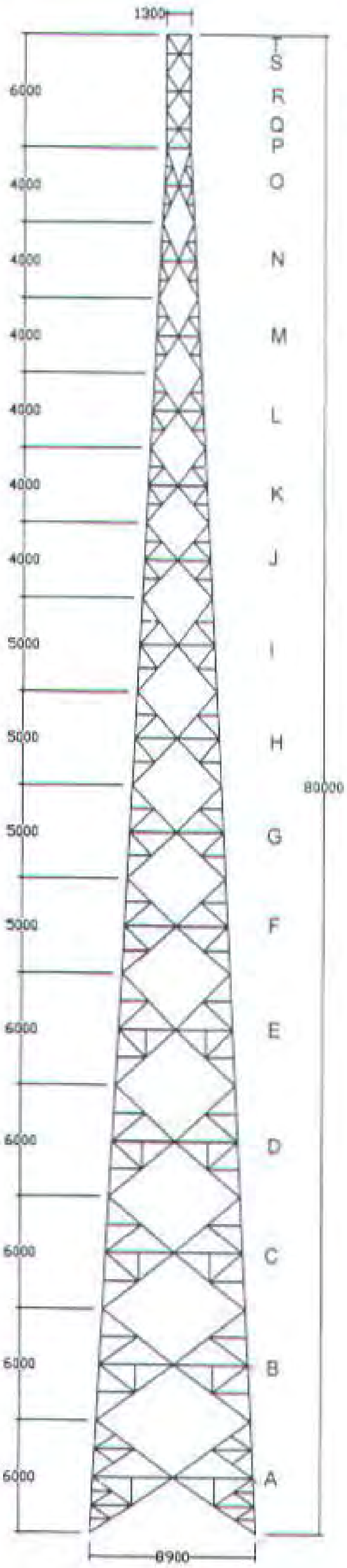
1. Sondir (terlampir)
2. Boring(terlampir)

2.3. Mutu Bahan

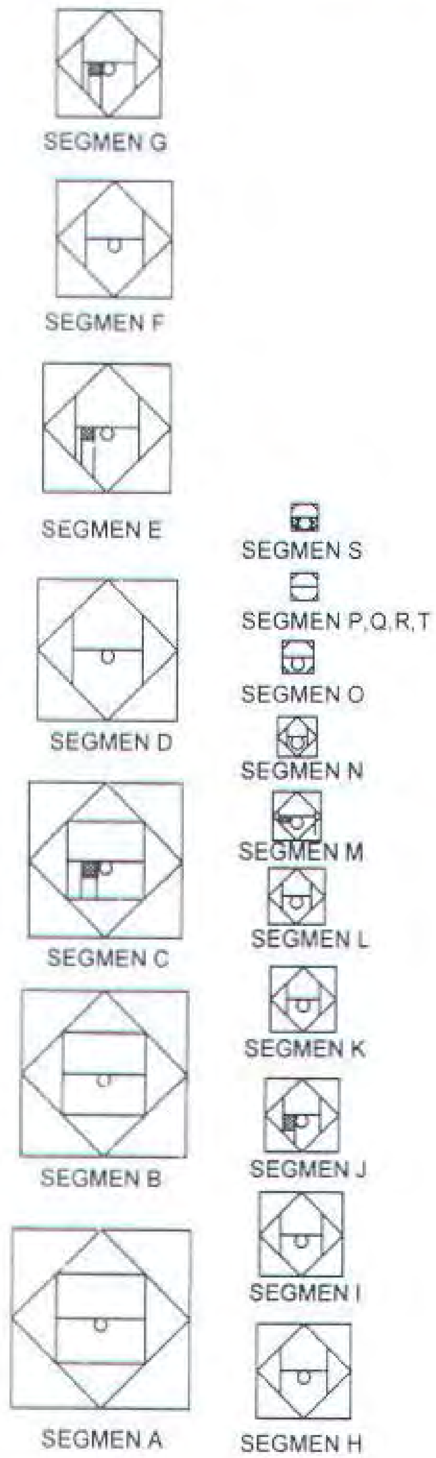
1. Baja siku BJ 37 ; fu = 3700 kg/cm^2 fy = 2400 kg/cm^2
2. Pelat BJ 37 ; fu = 3700 kg/cm^2 fy = 2400 kg/cm^2
3. Baut ; fu = 3700 kg/cm^2 fy = 2400 kg/cm^2
4. Tulangan beton fy = 400 Mpa
5. Mutu beton fc' = 250 Mpa

2.4. Modifikasi Alternatif Desain

Bentuk dari berbagai bentuk modifikasi bracing tersebut dapat di gambarkan pada gambar berikut ;

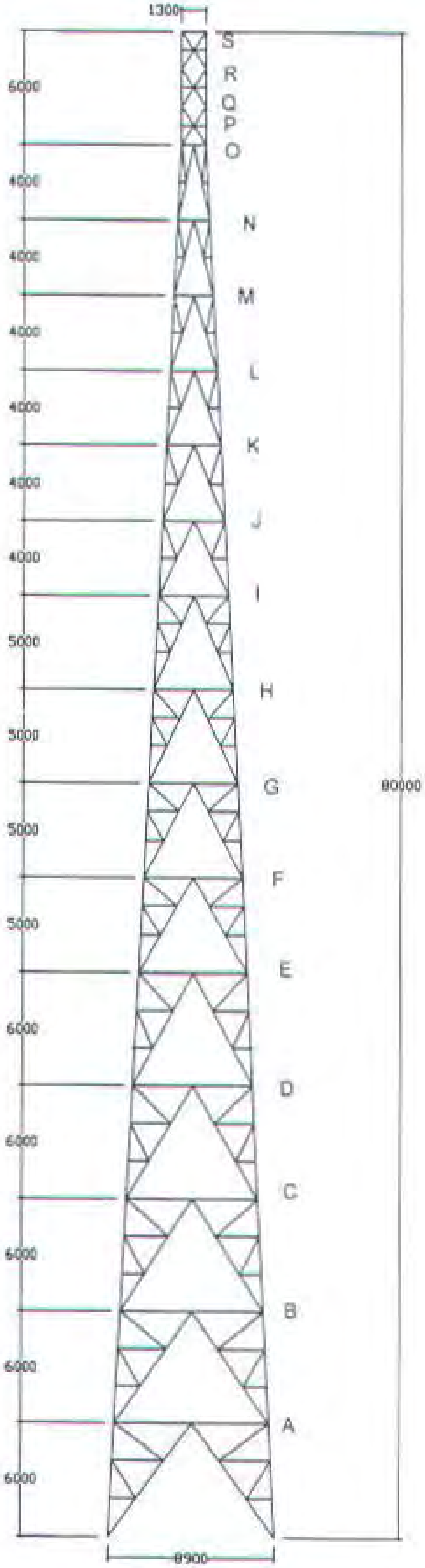


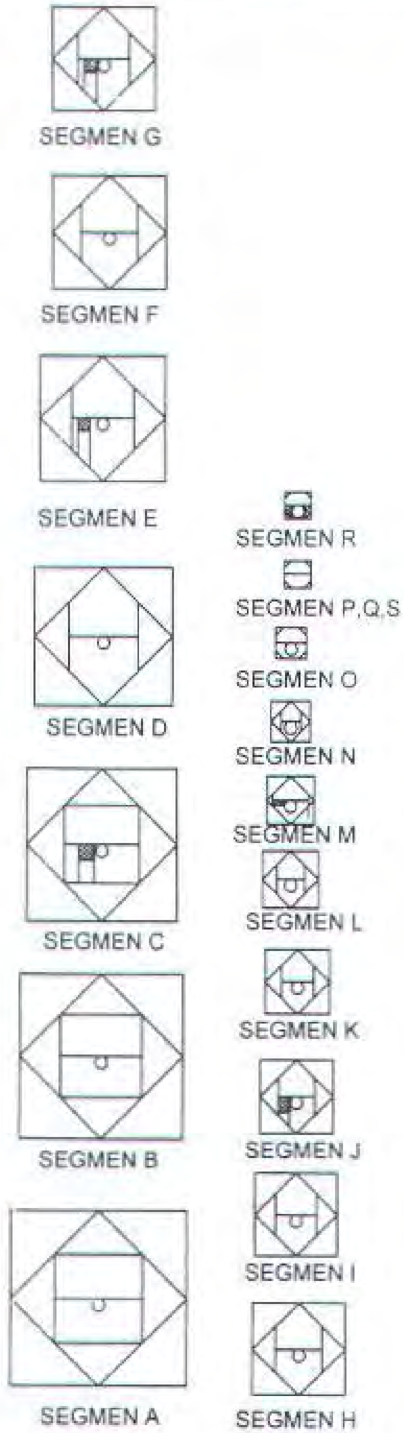
TIPE ANTENA	BERAT	JUMLAH	LETAK
Sector/CDMA	15 kg	4 buah	+76 m
Solid dish 1.2 m	90kg	4 buah	+62 m
Solid dish 0.6 m	35kg	4 huah	+70 m



Gambar 2.1. Desain sebelum modifikasi

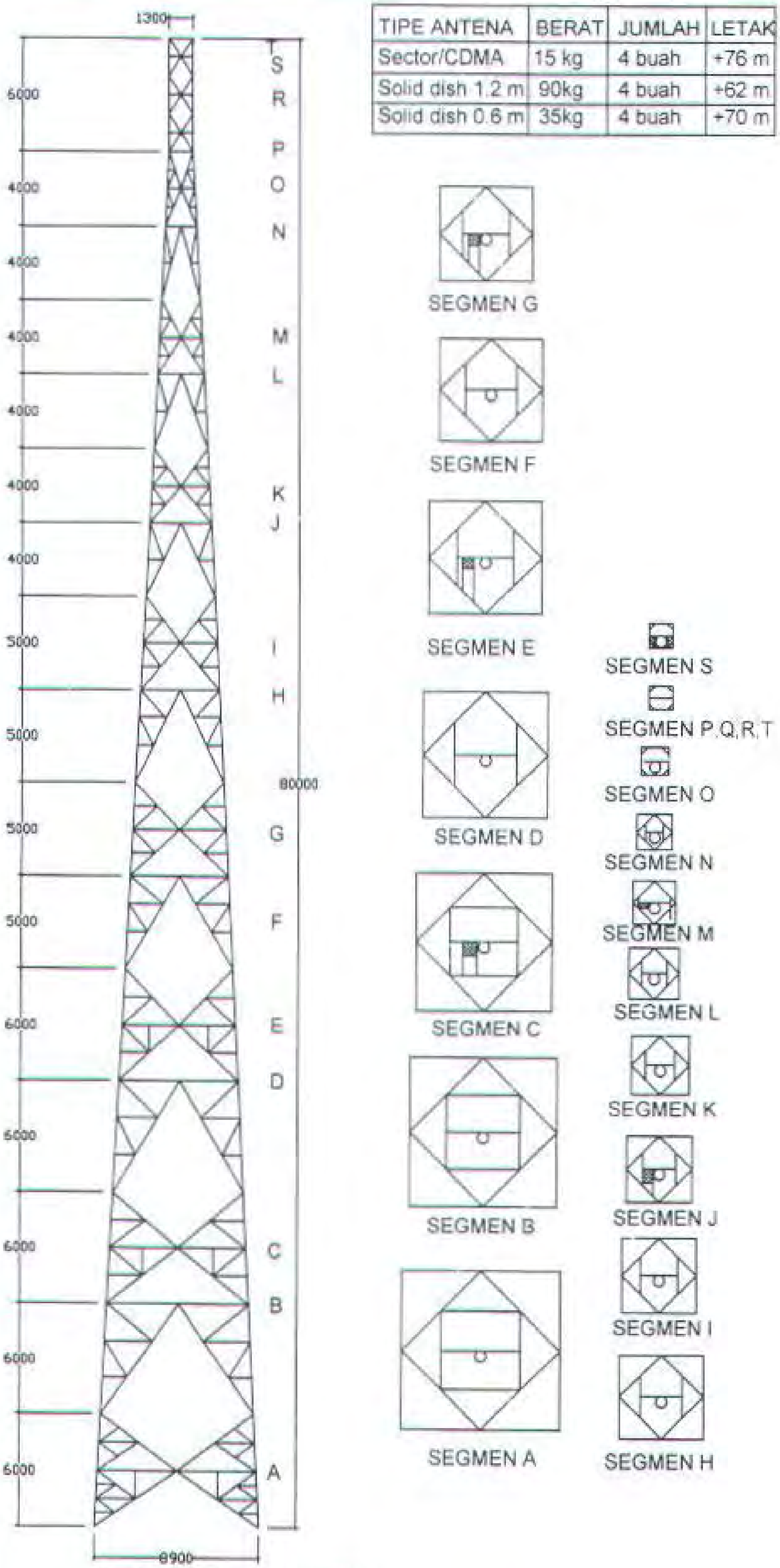
TIPE ANTENA	BERAT	JUMLAH	LETAK
Sector/CDMA	15 kg	4 buah	+76 m
Solid dish 1.2 m	90kg	4 buah	+62 m
Solid dish 0.6 m	35kg	4 buah	+70 m





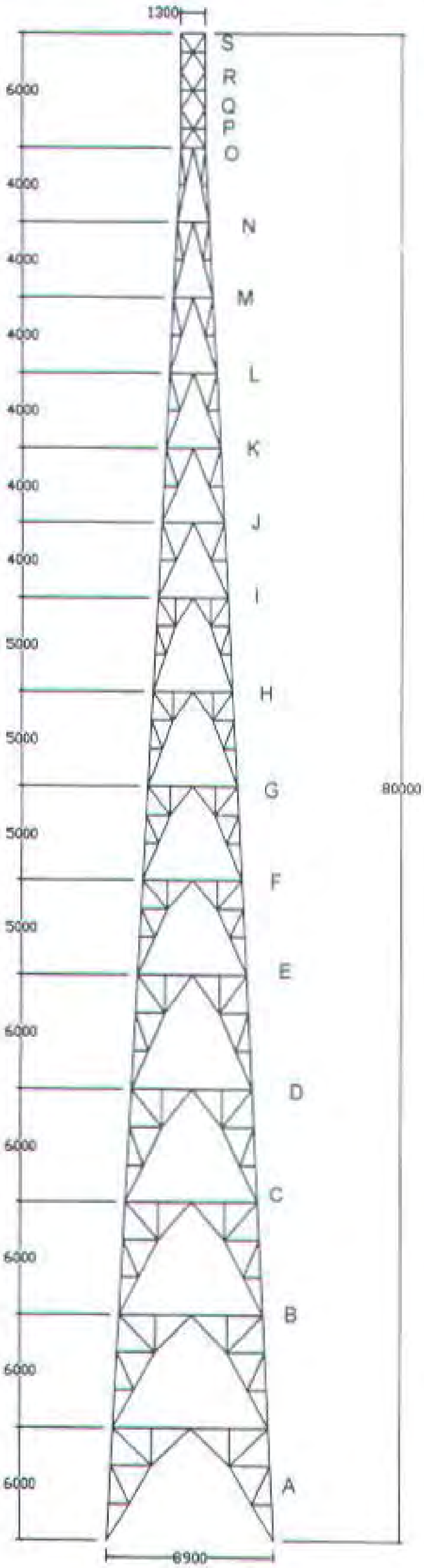
Gambar2.2 . Desain alternatif I

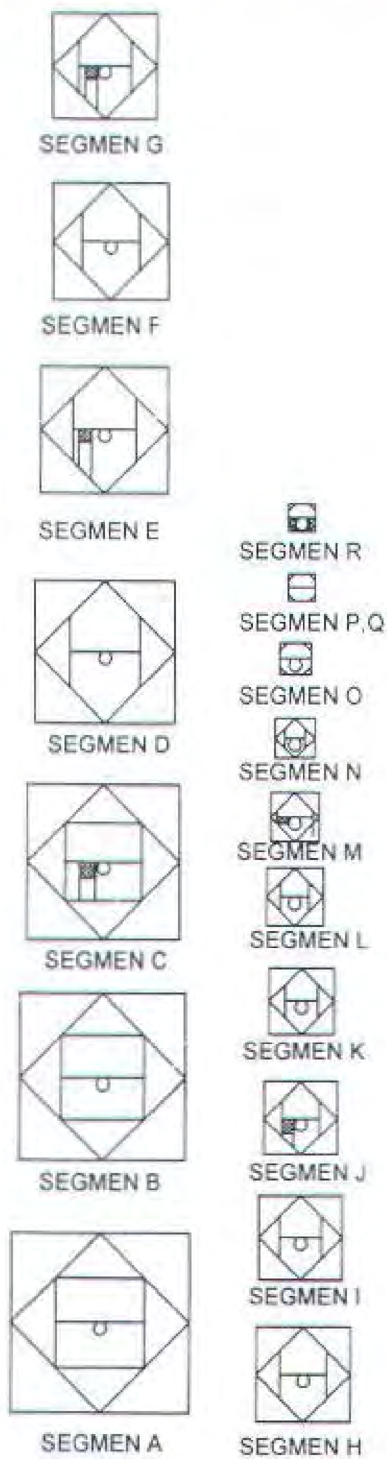
TIPE ANTENA	BERAT	JUMLAH	LETAK
Sector/CDMA	15 kg	4 buah	+76 m
Solid dish 1.2 m	90kg	4 buah	+62 m
Solid dish 0.6 m	35kg	4 buah	+70 m



Gambar 2.3. Desain alternatif 2

TIPE ANTENA	BERAT	JUMLAH	LETAK
Sector/CDMA	15 kg	4 buah	+76 m
Solid dish 1.2 m	90kg	4 buah	+62 m
Solid dish 0.6 m	35kg	4 buah	+70 m





Gambar 2.4. Desain alternatif 3

BAB III

DASAR-DASAR PERENCANAAN

BAB III

DASAR-DASAR PERENCANAAN

3.1. Pedoman Perhitungan

Pada tugas akhir ini perhitungan menggunakan konsep LRFD dari Tata Cara Perencanaan Struktur Baja untuk Bangunan Gedung tahun 2000. LRFD adalah konsep berdasarkan philosophi limit states (keadaan batas), yaitu suatu kondisi dimana struktur atau beberapa bagian dari struktur menunjukkan perilaku tidak dapat berfungsi.

Bagian perhitungan sesuai konsep Tata Cara Perencanaan Struktur Baja untuk Bangunan Gedung tahun 2000 adalah sebagai berikut:

3.1.1. Perhitungan Akibat Gaya Tarik Dan Tekan

Struktur tower baja diharapkan dapat menahan gaya tarik dan gaya tekan aksial akibat adanya beban – beban yang bekerja. Komponen struktur yang memikul gaya tarik aksial terfaktor Nu harus memenuhi:

$$Nu \leq \phi\, Nn$$

Dengan ϕ Nn adalah kuat tarik rencana yang besarnya diambil sebagai nilai terendah diantara dua perhitungan menggunakan harga – harga ϕ dan Nn di bawah ini:

$$\phi = 0{,}9$$

$$Nn = Ag\ Fy$$

dan

$$\phi = 0{,}75$$

$$Nn = Ae\ Fu$$

Dimana Ag = luas penampang bruto (mm^2)

Ae = luas penampang efektif (mm^2)

Fy = tegangan leleh (Mpa)

Fu = tegangan tarik putus (Mpa)

Ae = A U

A = luas penampang netto

U = adalah faktor reduksi = $1 - (x/L) \leq 0{,}9$

x = eksentrisitas sambungan , jarak tegak lurus arah gaya tarik antara titik berat penampang komponen yang disambung dengan bidang sambungan (mm)

Sedangkan suatu struktur yang mengalami gaya tekan akibat beban terfaktor Nu, harus memenuhi persyaratan sebagai berikut:

1. $Nu \leq \phi Nn$

   Keterangan:

   ϕ adalah faktor reduksi kekuatan sebesar 0,85

   Nn adalah kuat tekan nominal komponen struktur yang ditentukan berdasarkan butir 7.6.2 (Tata cara PSBUBG)

   $$Nn = Ag\frac{Fy}{w}$$

   Kelangsingan kolom (λc) $= \frac{1}{\pi}\lambda\sqrt{\frac{Fy}{E}}$

   $$\lambda = \frac{Lk}{r}$$

   $\lambda c \leq 0,25 \Rightarrow w = 1$

   $0,25 < \lambda c < 1,2 \Rightarrow w = \frac{1,43}{1,6 - 0,67\lambda c}$

   $\lambda c > 1,2 \Rightarrow w = 1,25\lambda c^2$

2. Perbandingan kelangsingan.

   - kelangsingan elemen penampang $< \lambda r$ (lihat tabel 7.5-1 PSBUBG)

   Untuk profil siku $b/t < \lambda r = \frac{200}{\sqrt{fy}}$

   - kelangsingan komponen struktur tekan , $\lambda = \frac{Lk}{r} < 200$

   Lk = panjang tekuk

   Lk = Kc x L

Untuk batang tekan dalam struktur segitiga Lk tidak boleh diambil kurang dari panjang teoritis batang.

Kc = faktor tekuk

L = panjang batang

r = jari – jari girasi

3.1.2. Kekuatan Baut

Suatu baut yang memikul gaya terfaktor, Ru, harus memenuhi:

$$Ru \leq \phi Rn$$

Dimana : ϕ= faktor reduksi kekuatan

Rn = kuat nominal baut

Kekuatan baut tipe tumpu dapat dihitung sebagai berikut:

Kuat geser : $\phi Rn = 0{,}75 \times (0{,}5xFu) \times n \times b$

Fu = tegangan putus baut.

Ab = luas penampang baut.

Kuat tumpu : $\phi Rn = 0{,}75 \times (2{,}4xdxtpxFu)$

Fu = tegangan putus baut/pelat mana yang kecil

d = diameter baut

tp = tebal pelat terkecil

ϕRn = harga terkecil dari kuat geser dan kuat tumpu.

$$\text{Banyaknya baut } (n) = \frac{Vu}{\phi Rn}$$

n = minimal 2 baut

Kontrol kekuatan pelat penyambung :

$$\left[\left(\frac{Nut}{\phi txNnt}\right)+\left(\frac{Mu}{\phi bxMn}\right)\right]^2+\left(\frac{Vu}{\phi vxVn}\right)^2 \leq 1$$

Nut = gaya normal

Mu = momen

Vu = gaya lintang / geser

$\phi t \times Nnt$ = harga terkecil dari

$= 0{,}9 \times Fy \times Ag$

$= 0{,}75 \times Fu \times An$

$\phi b \times Mn = 0{,}9 \times Z \times Fy$

$\phi v \times Vn = 0{,}75 \times (0{,}6 \times An \times Fu)$

3.2. Kriteria Desain

Berdasarkan standart EIA – 222F "Structural Standards for Steel Antenna Towers And Antenna Supporting Structures", struktur tower harus memenuhi syarat-syarat agar dalam pelayanan dapat berfungsi dengan baik yaitu:

a. Defleksi $\leq \frac{H}{100}$, dimana H = tinggi tower. (H dalam meter)

b. Sway / goyangan $\leq 0{,}5°$.

c. Twits/puntir $\leq 0{,}5°$.

3.3. PERATURAN YANG DIPAKAI

1. Tata Cara Perencanaan Struktur Baja untuk Bangunan Gedung Menggunakan Metoda LRFD.
2. Peraturan Pembebanan Indonesia untuk Gedung 1983.
3. Tata Cara Perhitungan Struktur Beton untuk Bangunan Gedung SK SNI T-15-1991-03.
4. Uniform Building Code (UBC) ,1997

BAB IV

PERHITUNGAN PEMBEBANAN

BAB IV
PERHITUNGAN PEMBEBANAN

4.1. Perhitungan Beban Mati

Beban mati ialah berat dari semua bagian struktur yang bersifat tetap.Ada dua jenis beban mati yang digunakan untuk perhitungan struktur tower , meliputi :

4.1.1 Berat sendiri struktur tower.

Perhitungan berat sendiri dalam analisa struktur dengan menggunakan program SAP2000,langsung bisa dihitung pada menu Define/Static Load Case dengan pengali berat sendiri ialah satu.

4.1.2 Beban antena.

Struktur tower ini didesain dengan beban antena sesuai dengan spesifikasi yang telah ditentukan. Untuk struktur tower dengan tinggi 80 meter beban antena sebagai berikut:

Tabel 4.1. Berat dan perletakan antena pada tower

Tipe Antena	Berat	Jumlah	Letak Antenna	Sudut antena
Sector/CDMA	15 kg	4 buah	76 m	0°,110°,230°,340°
Solid dish diameter 1,2 m	90 kg	4 buah	62 m	0°,150°,220°,310°
Solid dish diameter 0,6 m	35 kg	4 buah	70 m	90°,130°,260°,320°

4.2. Perhitungan Beban Hidup

Beban hidup ialah semua beban yang terjadi akibat penggunan tower.

4.2.1. Beban hidup pada anak tangga dan pelindung

Berdasarkan TIA/EIA-222-F (bagian 13.2.2) beban hidup pada anak tangga dan pelindung adalah sebesar 1,1 kN (110 kg)

4.2.2.Beban hidup pada pegangan bordes (guardril) dan pegangangan tangga

Berdasarkan TIA/EIA-222-F (bagian 13.2.5) beban hidup pada anak tangga dan pelindung adalah sebesar 0,67 kN (67 kg)

4.2.3 Beban hidup pada bordes

Beban hidup pada bordes ini direncanakan sebesar 1,2kPa (120 kg/m^2),(TIA/EIA-222-F bagian 13.2.4) terdistribusi pada joint-joint platform/bordes.

Perhitungan beban hidup tersebut dapat ditabelkan sebagai berikut:

Tabel 4.2. Perhitungan beban hidup pada bordes

qL = 120 kg/m2

Nomer	Segmen	Elevasi Bordes (m)	Pajang Bordes1 (m)	Panjang Bordes2	Lebar Bordes (m)	Luas Bordes (m2)	Beban (kg)	Jumlah Titik (bh)	Beban Perjoint (kg)
1	2	3	4	4	5	6	7	8	9
1	C	15	0.75	0.75	0.75	0.56	67.50	4	16.88
2	E	27	0.60	0.60	0.60	0.36	43.20	4	10.80
3	G	37.5	0.60	0.60	0.60	0.36	43.20	4	10.80
4	J	52	0.75	0.75	0.56	0.42	50.40	4	12.60
5	M	64	0.53	0.53	0.29	0.15	18.44	4	4.61
6	S	79	0.65	0.33	0.33	0.16	19.40	5	3.88

4.3. Perhitungan Beban Angin

4.3.1. Beban Angin Pada Struktur Tower

Beban angin pada struktur tower baja ini, dihitung sesuai dengan standart TIA/EIA-222-F (Teleominications Industry Association/Electronic Industries Association-Bagian 2 Loading). Gaya tiup angin ditentukan berdasarkan rumus .

$F = qz.G_H (C_F A_E + \Sigma C_A.A_A)$, namun tidak boleh melebihi= $2.qz.G_H.A_G$

$qz = 0.613.Kz.V^2$

$Kz = (z/10)^{2/7}$

$G_H = 0.65 + 0.6 (h/10)^{1/7}$

$C_F = 3.4e^2 - 4.7e + 3.4$

$A_E = D_F..A_F$

$e = A_F / A_G$

Dimana: F = Gaya tiup angin (N)

qz = Tekanan angin (N/m2)

Kz = Koefesien angin karena ketinggian tower

$1 < Kz < 2.58$

G_H = Faktor respon hembusan angin

$1 < G_H < 1.25$

h = Tinggi total struktur tower (m)

z = Tinggi segmen (m)

e = solidity ratio

V = Kecepatan angin (120 kph =33,33 m/det)

A_E= Luasan efektif persegmen

A_F = Luas penampang material per segmen(m^2).

A_G=Luas persegmen (m^2).

C_F=Koefesien gaya pada struktur tower

Sebagai contoh perhitungan beban angin untuk modifikasi tower 80 meter desain alternatif awal pada segmen A dengan ketinggian 3 m sebagai berikut;

a. Penentuan luas penampang material persegmen (A_F)

Luas penampang persegmen dihitung berdasrkan penempag material yang terkena tiupan angin.

- Panjang tiang utama	= 12 m (L 200.200.20), A_F = 12 x 0,2 =2,4 m^2
- Panjang sub tiang	= 3,2 m (L 60.60.6), A_F = 3,2 x 0,06 = 0,16 m^2
- Panjang horizontal utama	= 8,6 m (L 70.70.7), A_F = 8,6 x 0,07 = 0,6 m^2
- Panjang sub horizontal	= 16 m (L 60.60.6), A_F = 16 x 0,06 = 0,96 m^2
- Panjang diagonal utama	= 20m (L 100.100.10), A_F = 20 x 0,1 = 2 m^2
- Panjang sub diagonal	= 14,4 m (L 60.60.6), A_F = 14,4 x 0,06 = 0,86 m^2
Jumlah A_F segmen A	= 6,99 m^2

b. Menentukan luas persegemen (A_G)

Luasan persegemen merupakan area yang dicakup oleh segmen tersebut, dan dihitung berdasarkan perkalian antara leber segmen dengan selisih tinggi antara segmen yang ditinjau dengan segmen dibawah dan segmen di atasnya Khusus untuk segmen A(dasar), luasan segmen dihitung dari dasar tower sampai setengah bentang antara segmen A dan segmen B dikalikan dengan lebar segmen A.

Untuk nilai A_G pada segmen A =8,59 x 6 =51,55m2

c. Menentukan koefesien angin karena ketinggian tower (Kz)

$Kz = (z/10)^{2/7}$,dimana pada segmen A nilai z = 3 meter, sehingga;

$Kz = (3/10)^{2/7} = 0,7$ karena persyaratan $1 < Kz < 2.58$ tidak terpenuhi. maka diambil nilai Kz=1

d. Menentukan nilai tekanan angin (qz)

$qz = 0.613.Kz.V^2$, dimana Kz=1, V=33,33 m/det

qz = 681,1 Pa (N/m2) = 68,11 kg/m2

e. Menentukan faktor respon hembusan angin (G_H)

$G_H = 0.65 + 0.6\,(h/10)^{1/7}$,dimana h= 80 meter

$G_H = 1,10$

f. Menetukan nilai solidity ratio (e)

$e = A_F / A_G$, dimana A_F=6,99 m2, A_G=51,55m2

e = 0,14

g. Menentukan nilai koefesien gaya pada struktur tower (C_F)

$C_F = 3.4e^2 - 4.7e + 3.4$, dimana e =0,14

$C_F = 3,27$

h. Menentukan nilai factor arah angin (D_F)

Faktor arah angin dapat dilihat di table 2 TIA/EIA, untuk tower segiempat dengan arah angin normal nilai D_F adalah 1, sedangkan utuk arah angin ± 45° adalah 1+.75e(1,2mak)

i. Menentukan nilai luasan efektif persegmen (A_E)

Nilai luasan efektif persegmen (A_E)dapat dicari dengan perumusan sebagai berikut;

$A_E = D_F..A_F$, dimana D_F= 1, $A_F = 6,99\ m^2$

A_E= 6,99

j. Menentukan nilai luas penampang perlengkapan tower (A_A)

Yang dimaksud dengan perlengkapan tower adalah tangga beserta pelindungya. Luas penampang perlengkapan tower (A_A) persegmen dihitung tegak lurus berdasarkan arah angin. Pada tower PT. Mobile 8 Telecom ini hanya mempunyai satu buah tangga beserta pelindungnya. Bila diketahui pada segmen A lebar tangga (L_A) adalah 0,5m dan tinggi segmen (h_A) =6 m maka ;

$A_A = L_A\, h_A$

A_A = 3 m2

k. Menentukan nilai coefesien perlengkapan tower (C_A)

Nilai C_A ditentukan berdasarkan table 3 TIA/EIA, apabila nilai aspek rasio tidak terdapat di table, maka dapat dilakukan interpolasi data. Aspek rasio adalah perbandingan dari tinggi segmen (h_A) dan lebar segemen (L_A). Bila diketahui pada segmen A lebar tangga (L_A) adalah 0,5m dan tinggi segmen (h_A) =6 m maka ;

Aspec ratio = h_A / L_A =12 .Nilai aspek rasio tersebut tidak terdapat pada tebel tersebut, sehingga dapat dicari dengan interpolasi. Dari hasil iterpolasi didapat

C_A =1,42

l. Menentukan gaya tiup angin (F)

Nilai gaya tiup angin (F) dihitung berdasarkan perumusan;

$F = qz.\ G_H\ (C_F\ A_E + \Sigma C_A.A_A)$, namun tidak boleh melebihi= $2.qz.G_H.A_G$

Bila pada segemen A diketahui;

qz = 68,11 kg/m2

G_H = 1,10

C_F = 3,27

A_E = 6,99

A_G = 51,55m2

Karena pada tower PT. Mobile 8 Telecom ini hanya mempunyai 1(satu) buah tangga dan pelidungnya, maka ;

$\Sigma C_A.A_A$ = 1,42x 4,2 = 5,96 m2

Maka F = $qz.\ G_H\ (C_F\ A_E + \Sigma C_A.A_A)$ =2325,3 kg

= $2.qz.G_H.A_G$ = 77244 kg, maka di pilih nilai F = 2325,3 kg

m. Menetukan pembebanan pada tiap-tiap joint/titik (H)

Untuk menentukan pembebanan pada masing-masing joint, kita melakukan pembagian nilai gaya tiup angin (F) dibagi dengan jumlah join/titik.

Pada kasus segmen A, banyaknya joint/titik (n) adalah 33 titik sehingga gaya yang bekerja pada tiap-tiap joint (H) adalah F/n = 70,4 kg

Secara keseluruhan penentuan beban angin untuk 3 (tiga) alternatif modifikasi tower tersebut dapat dilihat pada tabel *Tabel 4.3, Tabel 4.4, Tabel 4.5*

4.3.2 Beban Angin pada Antena

Beban angin pada antena dihitung seperti beban angin pada struktur tower di atas,sesuai dengan rumus :

$F_A = C_A. A. K_Z. G_H. V^2$ (lb)

$F_S = C_S. A. K_Z. G_H. V^2$ (lb)

$Kz = (z/10)^{2/7}$

$G_H = 0.65 + 0.6 (h/10)^{1/7}$

Dimana ; F_A = Gaya axial pada antenna

F_S = Gaya samping pada antenna

A = Luas permukaan antenna (sq ft)

Kz = Coefficient angin karena ketinggian tower ($1 < Kz < 2.58$)

G_H = Faktor respon hembusan angin ($1 < G_H < 1.25$)

V = Kecepatan angin (120 kph =33,33 m/det =74,57 mph)

C_A, C_S = Koefesien gaya (table B1-B6 TIA/EIA)

Sebagi contoh perhitungan diambil tipe antenna solid dish diameter 1,2 m (3,9 ft) pada elevasi/ ketinggian 62m dengan sudut 0° dari arah utara ;

a. Menentukan faktor respon hembusan angin (G_H)

   $G_H = 0.65 + 0.6 (h/10)^{1/7}$,dimana h= 62 meter

   $G_H = 1,11$

b. Menentukan koefesien angin karena ketinggian antena (Kz)

   $Kz = (z/10)^{2/7}$,dimana pada segmen A nilai z = 65 meter, sehingga;

   $Kz = (62/10)^{2/7} = 1,68$

c. Menetukan koefesian antenna (C_A dan C_S)

   Nilai C_A dan C_S berdasarkan table B3 adalah 0,0023 dan 0,0000

d. Menentukan gaya axial pada antenna (F_A)

   $F_A = C_A. A. K_Z. G_H. V^2$

   $= 0,0023 \times 0,25.\pi.3,9^2 \times 1,68 \times 1,11 \times 74,57^2 = 102,36$ lb

e. Menentukan gaya samping pada antenna (F_S)

   $F_S = C_S. A. K_Z. G_H. V^2$

   $= 0,0000 \times 0,25.\pi.3,9^2 \times 1,68 \times 1,11 \times 74,57^2 = 0$ lb

Secara keseluruhan penentuan beban angin untuk 3 (tiga) alternatif modifikasi tower tersebut dapat dilihat pada tabel *Tabel 4.6*

4.4. Perhitungan Beban Gempa

Perhitungan beban gempa pada struktur tower ini, dilakukan dengan analisa gempa dinamis. Sesuai dengan Pedoman UBC 1997 analisa dinamis harus dilakukan untuk struktur yang tingginya lebih dari 40 m. Struktur tower ini mempunyai ketinggian 80 m ,tentunya harus digunakan analisa gempa dinamis. Dalam hal ini analisa beban gempa dinamis menggunakan analisa respons spektrum. Analisa respons sepektrum adalah suatu cara analisa dinamik struktur, dimana pada suatu model matematik dari struktur diberlakukan suatu spectrum respons gempa rencana,dan berdasarkan hal tersebut ditentukan respons struktur terhadap gempa rencana tersebut melalui superposisi dari respon masing-masing ragamnya.

Data-data yang diperlukan untuk perhitungan gempa dinamis asalah:

a. Berdasarkan data tanah dari laboratorium, nilai Undrained Shear Strength rata-rata adalah 1150 Kpa, sehingga sesuai dengan tabel 16 J UBC-Soil ProfileType termasuk dalam criteria SD (Stiff Soil Profile)
b. Koefesien Gempa Ca= 0,36 (tabel 16-R)dan Cv=0.54(tabel 16-Q)
c. Perhitungan periode gempa (period) dan koefesien percepatan (spectral accelaration) di tabelkan di table 4.10
d. Selanjutnya untuk perhitungan gempa analisa dimanis dengan data respon spectrum yang dilakukan oleh program SAP 2000. Perhitungan massa tiap segmen diperoleh dari berat tiap segmen dibagi dengan percepatan gravitasi (9,81m/dt2)

Masing-masing dari segmen tersebut dihitung massanya dan ditentukan pusat massa tersebut pada tengah – tengah diapragma yang ditentukan. Sebelumnya diapragma masing-masing segmen tersebut harus diconstrint,sehingga semua joint yang diconstrain tersebut dapat bergerak bersama sebagai diapragma kaku . Perilaku diapragma tersebut diwakili oleh sebuah master of joint yang terletak pada pusat massa dari masing-masing segmen tersebut.

4.5. Analisa Struktur Tower

Pada dasarnya tujuan utama analisa struktur adalah untuk mendapatkan besar dan arah gaya-gaya dalam yang diterima setiap elemen struktur. Pada perencanaan struktur tower ini analisa struktur dilakukan dengan bantuan program SAP2000 (Structural Analysis Program 2000),dengan model struktur frame 3 dimensi. Untuk menyalurkan gaya lateral supaya diterima oleh elemen struktur penahan gaya lateral, maka struktur dibagi menjadi segmen-segmen dimodelkan sebagai dipragma yang kaku. Jadi seluruh joint dalam satu bidang dengan pusat massa pada segmen masing–masing diconstrain, sehingga joint-joint tersebut dapat bergerak bersama-sama. Dengan pengunaan diapragma ini massa tiap segmen dapat diberikan pada salah satu joint saja.

4.6. Kombinasi Pembebanan

Kombinasi pembebanan diambil dari peraturan Tata Cara Perencanaan Struktur Baja untuk Bangunan Gedung tahun 2000 adalah sebagai berikut :

Kombinasi 1 = 1,4D

Kombinasi 2 = 1,2D + 1,6L

Kombinasi 3 = 1,2D + 0,5L +1,3 ($W_1 + W_3$)

Kombinasi 4 = 1,2D + 0,5L +1,3 ($W_2 + W_3$)

Kombinasi 5 = 1,2D + 0,5L +1E

Kombinasi 6 = 0,9D - 1,3 ($W_1 + W_3$)

Kombinasi 7 = 0,9D - 1,3 ($W_2 + W_3$)

Kombinasi 8 = 0,9D - 1E

Dimana :

D = beban mati

L = beban hidup

W_1 = beban angin arah tegak lurus rangka

W_2 = beban angin arah 45° terhadap rangka

W_3 = beban angin terhadap antena

E = beban gempa

Tabel 4.3 PERHITUNGAN PEMBEBANAN ANGIN TOWER (ALTERNATIF 1)
Rumus perhitungan pembebanan angin mengacu TIA/EIA-222-F

Proyek: TUGAS AKHIR
Lokasi : BANGIL
Tinggi Tower : 80 meter

Kecepatan angin: 120 kph
33.33 $m.s^{-1}$
Faktor kec.angin: 0.613

ARAH ANGIN : NORMAL

D_F = 1 ....Tabel 2 TIA
C_A = 1.42 .... Tabel 3 TIA

SEC.	Elevasi (m)	Lebar (m)	Panjang (m)	A_F (m2)	A_G (m2)	Kz	qz (kg/m2)	G_H	e (A_F/A_G)	C_F	D_F	A_F (m2)	A_A (m2)	F (Kg)	n (titik)	Fi (Kg/Titik)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18
A	6.00	8.28	9.00	9.12	75.94	1.000	68.11	1.10	0.12	3.35	1.00	9.12	6.30	2946.82	17	173.34
B	12.00	7.67	6.00	5.74	46.01	1.053	71.75	1.10	0.12	3.33	1.00	5.74	4.20	1970.61	11	179.15
C	18.00	7.05	6.00	5.30	42.31	1.183	80.57	1.10	0.13	3.32	1.00	5.30	4.20	2081.41	11	189.22
D	24.00	6.44	6.00	4.86	38.61	1.284	87.47	1.10	0.13	3.32	1.00	4.86	4.20	2117.23	11	192.48
E	30.00	5.82	5.50	4.04	32.15	1.369	93.23	1.10	0.13	3.32	1.00	4.04	3.85	1930.46	11	175.50
F	35.00	5.31	5.00	3.34	26.53	1.430	97.42	1.10	0.13	3.32	1.00	3.34	3.50	1713.81	11	155.80
G	40.00	4.79	5.00	3.03	23.96	1.486	101.21	1.10	0.13	3.32	1.00	3.03	3.50	1665.94	11	151.45
H	45.00	4.28	5.00	2.72	21.39	1.537	104.68	1.10	0.13	3.31	1.00	2.72	3.50	1604.52	11	145.87
I	50.00	3.76	4.50	2.17	17.06	1.584	107.88	1.10	0.13	3.31	1.00	2.17	3.15	1379.42	11	125.40
J	54.00	3.35	4.00	1.71	13.42	1.619	110.27	1.10	0.13	3.31	1.00	1.71	2.80	1164.55	7	166.36
K	58.00	2.94	4.00	1.51	11.77	1.652	112.55	1.10	0.13	3.31	1.00	1.51	2.80	1107.06	7	158.15
L	62.00	2.53	4.00	1.31	10.13	1.684	114.71	1.10	0.13	3.30	1.00	1.31	2.80	1045.25	7	149.32
M	66.00	2.12	4.00	1.12	8.49	1.715	116.78	1.10	0.13	3.29	1.00	1.12	2.80	979.46	7	139.92
N	70.00	1.71	4.00	0.92	6.84	1.744	118.76	1.10	0.13	3.28	1.00	0.92	2.80	909.95	7	129.99
O	74.00	1.30	2.50	0.45	3.51	1.772	120.66	1.10	0.13	3.31	1.00	0.45	1.75	526.01	2	263.01
P	75.00	1.30	1.50	0.23	1.95	1.778	121.13	1.10	0.12	3.35	1.00	0.23	1.05	301.93	5	60.39
Q	77.00	1.30	2.00	0.31	2.60	1.792	122.04	1.10	0.12	3.35	1.00	0.31	1.40	405.62	5	81.12
R	79.00	1.30	2.00	0.31	2.60	1.805	122.94	1.10	0.12	3.35	1.00	0.31	1.40	408.60	5	81.72

ARAH ANGIN : 45

D_F = 1+0,75e < 1,2 ....Tabel 2 TIA

C_A = 1.42 .... Tabel 3 TIA

SEC.	ELEV. (m)	Width (m)	mid point (m)	A_f (m2)	A_G (m2)	Kz	qz (kg/m2)	G_H	e (AF/AG)	CF	DF	A_f (m2)	A_A (m2)	F (Kg)	n (titik)	Fi (Kg/Titik)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18
A	6.00	8.28	9.00	9.12	74.55	1.000	68.11	1.10	0.12	3.34	1.09	9.95	6.30	3147.68	17	185.16
B	12.00	7.67	6.00	5.74	46.01	1.053	71.75	1.10	0.12	3.33	1.09	6.28	4.20	2111.19	11	191.93
C	18.00	7.05	6.00	5.30	42.31	1.183	80.57	1.10	0.13	3.32	1.09	5.80	4.20	2227.47	11	202.50
D	24.00	6.44	6.00	4.86	38.61	1.284	87.47	1.10	0.13	3.32	1.09	5.31	4.20	2262.99	11	205.73
E	30.00	5.82	5.50	4.04	32.00	1.369	93.23	1.10	0.13	3.32	1.09	4.43	3.85	2059.25	11	187.20
F	35.00	5.31	5.00	3.34	26.53	1.430	97.42	1.10	0.13	3.32	1.09	3.65	3.50	1825.45	11	165.95
G	40.00	4.79	5.00	3.03	23.96	1.486	101.21	1.10	0.13	3.32	1.09	3.32	3.50	1771.65	11	161.06
H	45.00	4.28	5.00	2.72	21.39	1.537	104.68	1.10	0.13	3.31	1.10	2.98	3.50	1703.21	11	154.84
I	50.00	3.76	4.50	2.17	16.94	1.584	107.88	1.10	0.13	3.31	1.10	2.38	3.15	1460.01	11	132.73
J	54.00	3.35	4.00	1.71	13.42	1.619	110.27	1.10	0.13	3.31	1.10	1.87	2.80	1229.89	7	175.70
K	58.00	2.94	4.00	1.51	11.77	1.652	112.55	1.10	0.13	3.31	1.10	1.66	2.80	1166.43	7	166.63
L	62.00	2.53	4.00	1.31	10.13	1.684	114.71	1.10	0.13	3.30	1.10	1.44	2.80	1098.32	7	156.90
M	66.00	2.12	4.00	1.12	8.49	1.715	116.78	1.10	0.13	3.29	1.10	1.23	2.80	1025.92	7	146.56
N	70.00	1.71	4.00	0.92	6.84	1.744	118.76	1.10	0.13	3.28	1.10	1.01	2.80	949.52	7	135.65
O	74.00	1.30	2.50	0.45	3.25	1.772	120.66	1.10	0.14	3.26	1.10	0.50	1.75	543.35	2	271.68
P	75.00	1.30	1.50	0.23	1.95	1.778	121.13	1.10	0.12	3.35	1.09	0.26	1.05	311.30	5	62.26
Q	77.00	1.30	2.00	0.31	2.60	1.792	122.04	1.10	0.12	3.35	1.09	0.34	1.40	418.19	5	83.64
R	79.00	1.30	2.00	0.31	2.60	1.805	122.94	1.10	0.12	3.35	1.09	0.34	1.40	421.27	5	84.25

Tabel 4.4 PERHITUNGAN PEMBEBANAN ANGIN TOWER (ALTERATIF 2)
Rumus perhitungan pembebanan angin mengacu TIA/EIA-222-F

Proyek: TUGAS AKHIR
Lokasi : BANGIL
Tinggi Tower : 80 meter

Kecepatan angin: 120 kph
33.33 $m.s^{-1}$
Faktor kec.angin: 0.613

ARAH ANGIN : NORMAL

D_F = 1 ....Tabel 2 TIA

C_A = 1.42 ....Tabel 3 TIA

SEC.	Elevasi (m)	Lebar (m)	Panjang (m)	A_F (m2)	A_G (m2)	Kz	qz (kg/m2)	G_H	e (A_F/A_G)	C_F	D_F	A_E (m2)	A_A (m2)	F (Kg)	n (titik)	Fi (Kg/Titik)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18
A	3.00	8.59	7.50	7.74	63.86	1.000	68.11	1.10	0.12	3.34	1.00	7.74	5.25	2487.25	28	88.83
B	12.00	7.67	6.00	5.85	46.93	1.053	71.75	1.10	0.12	3.33	1.00	5.85	4.20	1999.83	15	133.32
C	15.00	7.36	6.00	5.41	48.38	1.123	76.48	1.10	0.11	3.39	1.00	5.41	4.20	2036.78	11	185.16
D	24.00	6.44	6.00	4.97	34.39	1.284	87.47	1.10	0.14	3.23	1.00	4.97	4.20	2109.75	15	140.65
E	27.00	6.13	5.50	4.15	55.04	1.328	90.46	1.10	0.08	3.58	1.00	4.15	3.85	2012.38	11	182.94
F	35.00	5.31	5.25	3.60	6.55	1.430	97.42	1.10	0.55	1.97	1.00	3.60	3.68	1312.75	15	87.52
G	37.50	5.05	5.00	3.11	24.60	1.459	99.36	1.10	0.13	3.32	1.00	3.11	3.50	1663.61	9	184.85
H	45.00	4.28	5.00	2.80	22.03	1.537	104.68	1.10	0.13	3.32	1.00	2.80	3.50	1634.13	15	108.94
I	47.50	4.02	4.50	2.24	17.64	1.561	106.31	1.10	0.13	3.31	1.00	2.24	3.15	1386.42	8	173.30
J	54.00	3.35	4.25	1.88	14.75	1.619	110.27	1.10	0.13	3.31	1.00	1.88	2.98	1263.33	7	180.48
K	56.00	3.15	4.00	1.56	12.18	1.636	111.43	1.10	0.13	3.31	1.00	1.56	2.80	1116.19	13	85.86
L	62.00	2.53	4.00	1.36	10.54	1.684	114.71	1.10	0.13	3.30	1.00	1.36	2.80	1066.03	7	152.29
M	64.00	2.33	4.00	1.17	8.90	1.700	115.76	1.10	0.13	3.30	1.00	1.17	2.80	991.86	13	76.30
N	70.00	1.71	4.00	0.97	7.25	1.744	118.76	1.10	0.13	3.28	1.00	0.97	2.80	931.49	11	84.68
O	72.00	1.51	2.00	0.39	3.01	1.758	119.72	1.10	0.13	3.31	1.00	0.39	1.40	428.37	7	61.20
P	74.00	1.30	1.50	0.25	1.95	1.772	120.66	1.10	0.13	3.30	1.00	0.25	1.05	307.41	2	153.71
Q	75.00	1.30	1.50	0.23	1.95	1.778	121.13	1.10	0.12	3.35	1.00	0.23	1.05	301.93	5	60.39
R	77.00	1.30	2.00	0.31	2.60	1.792	122.04	1.10	0.12	3.35	1.00	0.31	1.40	405.62	5	81.12
S	79.00	1.30	2.00	0.31	2.60	1.805	122.94	1.10	0.12	3.35	1.00	0.31	1.40	408.60	5	81.72

ARAH ANGIN : 45

D_F = 1+0,75e < 1,2 .... Tabel 2 TIA

C_A = 1.42 .... Tabel 3 TIA

SEC.	ELEV. (m)	Width (m)	mid point (m)	A_F (m2)	A_G (m2)	Kz	qz (kg/m2)	G_H	e (AF/AG)	CF	DF	A_E (m2)	A_A (m2)	F (Kg)	n (titik)	Fi (Kg/Titik)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18
A	3.00	8.59	7.50	7.74	64.44	1.000	68.11	1.10	0.12	3.35	1.09	8.43	5.25	2664.48	28	95.16
B	12.00	7.67	6.00	5.85	46.01	1.053	71.75	1.10	0.13	3.31	1.10	6.41	4.20	2139.74	15	142.65
C	15.00	7.36	6.00	5.41	44.16	1.123	76.48	1.10	0.12	3.34	1.09	5.91	4.20	2151.75	11	195.61
D	24.00	6.44	6.00	4.97	38.61	1.284	87.47	1.10	0.13	3.31	1.10	5.45	4.20	2297.72	15	153.18
E	27.00	6.13	5.50	4.15	33.70	1.328	90.46	1.10	0.12	3.33	1.09	4.53	3.85	2038.72	11	185.34
F	35.00	5.31	5.25	3.60	27.85	1.430	97.42	1.10	0.13	3.30	1.10	3.95	3.68	1950.54	15	130.04
G	37.50	5.05	5.00	3.11	25.24	1.459	99.36	1.10	0.12	3.33	1.09	3.39	3.50	1773.02	9	197.00
H	45.00	4.28	5.00	2.80	21.39	1.537	104.68	1.10	0.13	3.30	1.10	3.07	3.50	1731.98	15	115.47
I	47.50	4.02	4.50	2.24	18.10	1.561	106.31	1.10	0.12	3.33	1.09	2.45	3.15	1471.32	8	183.91
J	54.00	3.35	4.25	1.88	14.25	1.619	110.27	1.10	0.13	3.29	1.10	2.07	2.98	1332.49	7	190.36
K	56.00	3.15	4.00	1.56	12.59	1.636	111.43	1.10	0.12	3.33	1.09	1.71	2.80	1179.06	13	90.70
L	62.00	2.53	4.00	1.36	10.13	1.684	114.71	1.10	0.13	3.28	1.10	1.50	2.80	1118.39	7	159.77
M	64.00	2.33	4.00	1.17	9.31	1.700	115.76	1.10	0.13	3.32	1.09	1.28	2.80	1042.24	13	80.17
N	70.00	1.71	4.00	0.97	6.84	1.744	118.76	1.10	0.14	3.24	1.11	1.07	2.80	970.10	11	88.19
O	72.00	1.51	2.00	0.39	3.01	1.758	119.72	1.10	0.13	3.31	1.10	0.42	1.40	444.48	7	63.50
P	74.00	1.30	1.50	0.25	1.95	1.772	120.66	1.10	0.13	3.30	1.10	0.28	1.05	318.12	2	159.06
Q	75.00	1.30	1.50	0.23	1.95	1.778	121.13	1.10	0.12	3.35	1.09	0.26	1.05	311.30	5	62.26
R	77.00	1.30	2.00	0.31	2.60	1.792	122.04	1.10	0.12	3.35	1.09	0.34	1.40	418.19	5	83.64
S	79.00	1.30	2.00	0.31	2.60	1.805	122.94	1.10	0.12	3.35	1.09	0.34	1.40	421.27	5	84.25

Tabel 4.5 PERHITUNGAN PEMBEBANAN ANGIN TOWER (ALTERNATIF 3)
Rumus perhitungan pembebanan angin mengacu TIA/EIA-222-F

Proyek: TUGAS AKHIR
Lokasi : BANGIL
Tinggi Tower : 80 meter

Kecepatan angin: 120 kph
33.33 $m.s^{-1}$
Faktor kec.angin: 0.613

ARAH ANGIN : NORMAL

D_F = 1 ....Tabel 2 TIA

C_A = 1.42 .... Tabel 3 TIA

SEC.	Elevasi (m)	Lebar (m)	Panjang (m)	A_F (m2)	A_G (m2)	Kz	qz (kg/m2)	G_H	e (A_F/A_G)	C_F	D_F	A_E (m2)	A_A (m2)	F (Kg)	n (titik)	Fi (Kg/Titik)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18
A	6.00	8.28	9.00	9.12	36.93	1.000	68.11	1.10	0.25	2.79	1.00	9.12	6.30	2564.33	15	170.96
B	12.00	7.67	6.00	5.74	46.01	1.053	71.75	1.10	0.12	3.33	1.00	5.74	4.20	1970.61	13	151.59
C	18.00	7.05	6.00	5.30	42.31	1.183	80.57	1.10	0.13	3.32	1.00	5.30	4.20	2081.41	13	160.11
D	24.00	6.44	6.00	4.86	38.61	1.284	87.47	1.10	0.13	3.32	1.00	4.86	4.20	2117.23	13	162.86
E	30.00	5.82	5.50	4.04	32.15	1.369	93.23	1.10	0.13	3.32	1.00	4.04	3.85	1930.46	13	148.50
F	35.00	5.31	5.00	3.34	26.53	1.430	97.42	1.10	0.13	3.32	1.00	3.34	3.50	1713.81	13	131.83
G	40.00	4.79	5.00	3.03	23.96	1.486	10'.21	1.10	0.13	3.32	1.00	3.03	3.50	1665.94	13	128.15
H	45.00	4.28	5.00	2.72	21.39	1.537	104.68	1.10	0.13	3.31	1.00	2.72	3.50	1604.52	13	123.42
I	50.00	3.76	4.50	2.17	17.06	1.584	107.88	1.10	0.13	3.31	1.00	2.17	3.15	1379.42	13	106.11
J	54.00	3.35	4.00	1.71	13.42	1.619	110.27	1.10	0.13	3.31	1.00	1.71	2.80	1164.55	7	166.36
K	58.00	2.94	4.00	1.51	11.77	1.652	112.55	1.10	0.13	3.31	1.00	1.51	2.80	1107.06	7	158.15
L	62.00	2.53	4.00	1.31	10.13	1.684	114.71	1.10	0.13	3.30	1.00	1.31	2.80	1045.25	7	149.32
M	66.00	2.12	4.00	1.12	8.49	1.715	116.78	1.10	0.13	3.29	1.00	1.12	2.80	979.46	7	139.92
N	70.00	1.71	4.00	0.92	6.84	1.744	118.76	1.10	0.13	3.28	1.00	0.92	2.80	909.95	7	129.99
O	74.00	1.30	2.50	0.45	3.51	1.772	120.66	1.10	0.13	3.31	1.00	0.45	1.75	526.01	2	263.01
P	75.00	1.30	1.50	0.23	1.95	1.778	121.13	1.10	0.12	3.35	1.00	0.23	1.05	301.93	5	60.39
Q	77.00	1.30	2.00	0.31	2.60	1.792	122.04	1.10	0.12	3.35	1.00	0.31	1.40	405.62	5	81.12
R	79.00	1.30	2.00	0.31	2.60	1.805	122.94	1.10	0.12	3.35	1.00	0.31	1.40	408.60	5	81.72

Tinggi Tower : 80 meter

ARAH ANGIN : 45

D_F = 1+0,75e < 1,2 ....Tabel 2 TIA

C_A = 1.42 .... Tabel 3 TIA

SEC.	ELEV. (m)	Width (m)	mid point (m)	A_f (m2)	A_G (m2)	Kz	qz (kg/m2)	G_H	e (AF/AG)	CF	DF	A_E (m2)	A_A (m2)	F (Kg)	n (titik)	Fi (Kg/Titik)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17	18
A	6.00	8.28	9.00	9.12	74.55	1.000	68.11	1.10	0.12	3.34	1.09	9.95	6.30	3147.68	15	209.85
B	12.00	7.67	6.00	5.74	46.01	1.053	71.75	1.10	0.12	3.33	1.09	6.28	4.20	2111.19	13	162.40
C	18.00	7.05	6.00	5.30	42.31	1.183	80.57	1.10	0.13	3.32	1.09	5.80	4.20	2227.47	13	171.34
D	24.00	6.44	6.00	4.86	38.61	1.284	87.47	1.10	0.13	3.32	1.09	5.31	4.20	2262.99	13	174.08
E	30.00	5.82	5.50	4.04	32.00	1.369	93.23	1.10	0.13	3.32	1.09	4.43	3.85	2059.25	13	158.40
F	35.00	5.31	5.00	3.34	26.53	1.430	97.42	1.10	0.13	3.32	1.09	3.65	3.50	1825.45	13	140.42
G	40.00	4.79	5.00	3.03	23.96	1.486	101.21	1.10	0.13	3.32	1.09	3.32	3.50	1771.65	13	136.28
H	45.00	4.28	5.00	2.72	21.39	1.537	104.68	1.10	0.13	3.31	1.10	2.98	3.50	1703.21	13	131.02
I	50.00	3.76	4.50	2.17	16.94	1.584	107.88	1.10	0.13	3.31	1.10	2.38	3.15	1460.01	13	112.31
J	54.00	3.35	4.00	1.71	13.42	1.619	110.27	1.10	0.13	3.31	1.10	1.87	2.80	1229.89	7	175.70
K	58.00	2.94	4.00	1.51	11.77	1.652	112.55	1.10	0.13	3.31	1.10	1.66	2.80	1166.43	7	166.63
L	62.00	2.53	4.00	1.31	10.13	1.684	114.71	1.10	0.13	3.30	1.10	1.44	2.80	1098.32	7	156.90
M	66.00	2.12	4.00	1.12	8.49	1.715	116.78	1.10	0.13	3.29	1.10	1.23	2.80	1025.92	7	146.56
N	70.00	1.71	4.00	0.92	6.84	1.744	118.76	1.10	0.13	3.28	1.10	1.01	2.80	949.52	7	135.65
O	74.00	1.30	2.50	0.45	3.25	1.772	120.66	1.10	0.14	3.26	1.10	0.50	1.75	543.35	2	271.68
P	75.00	1.30	1.50	0.23	1.95	1.778	121.13	1.10	0.12	3.35	1.09	0.26	1.05	311.30	5	62.26
Q	77.00	1.30	2.00	0.31	2.60	1.792	122.04	1.10	0.12	3.35	1.09	0.34	1.40	418.19	5	83.64
R	79.00	1.30	2.00	0.31	2.60	1.805	122.94	1.10	0.12	3.35	1.09	0.34	1.40	421.27	5	84.25

Tabel 4.6.PERHITUNGAN PEMBEBANAN ANGIN ANTENNA TOWER UNTUK SEMUA ALTERNATIF

Rumus perhitungan pembebanan angin mengacu TIA/EIA-222-F

Kecepatan angin:	120	kph			
	33.33	$m\,s^{-1}$	=	74.57	mph
Catatan :	1.00	m	=	0.3048	ft
	1.00	kg	=	0.448	lb

Arah angin 0°

Tipe Antenna	Panjang Antenna (m)	Lebar Antenna (m)	Diameter Antenna (m)	Diameter Antenna (ft)	Elv. Antenna (m)	Sudut Antenna (degree)	CA	CS	Kz	GH	A_A (sq.ft)	F_S (lb)	F_A (lb)	F_S (kg)	F_A (kg)	Berat Antenna (kg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Solid dish	-	-	1.20	3.94	62.00	0	0.00323	0.00000	1.68	1.11	3.042	0.00	102.36	0.00	45.86	90
	-	-	1.20	3.94	62.00	110	-0.00138	0.00136	1.68	1.11	3.042	43.10	-43.73	19.31	-19.59	90
	-	-	1.20	3.94	62.00	230	-0.00182	-0.00080	1.68	1.11	3.042	-25.35	-57.67	-11.36	-25.84	90
	-	-	1.20	3.94	62.00	340	0.00320	-0.00045	1.68	1.11	3.042	-14.26	101.41	-6.39	45.43	90
Solid dish	-	-	0.60	1.97	70.00	0	-0.00104	-0.00060	1.74	1.10	0.760	-4.89	-8.47	-2.19	-3.79	35
	-	-	0.60	1.97	70.00	150	-0.00245	-0.00045	1.74	1.10	0.760	-3.66	-19.95	-1.64	-8.94	35
	-	-	0.60	1.97	70.00	220	-0.00239	-0.00059	1.74	1.10	0.760	-4.80	-19.46	-2.15	-8.72	35
	-	-	0.60	1.97	70.00	310	0.00278	-0.00078	1.74	1.10	0.760	-6.35	22.64	-2.85	10.14	35
Sector	1.80	0.15	-	-	76.00	0	0.00351	0.00000	1.79	1.10	2.906	0.00	111.29	0.00	49.86	15
	1.80	0.15	-	-	76.00	130	0.00348	0.00029	1.79	1.10	2.906	9.20	110.34	4.12	49.43	15
	1.80	0.15	-	-	76.00	260	-0.00108	-0.00035	1.79	1.10	2.906	-11.10	-34.24	-4.97	-15.34	15
	1.80	0.15	-	-	76.00	320	0.00309	-0.00013	1.79	1.10	2.906	-4.12	97.98	-1.85	43.89	15

Arah angin 45°

Tipe Antenna	Panjang Antenna (m)	Lebar Antenna (m)	Diameter Antenna (m)	Diameter Antenna (ft)	Elv. Antenna (m)	Sudut Antenna (degree)	CA	CS	Kz	GH	A_A (sq.ft)	F_S (lb)	F_A (lb)	F_S (kg)	F_A (kg)	Berat Antenna (kg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Solid dish	-	-	1.20	3.94	62.00	45	0.00287	0.00075	1.68	1.11	3.042	23.77	90.95	10.65	40.75	90
	-	-	1.20	3.94	62.00	155	-0.00247	0.00042	1.68	1.11	3.042	13.31	-78.27	5.96	-35.07	90
	-	-	1.20	3.94	62.00	275	0.00021	-0.00154	1.68	1.11	3.042	-48.80	6.65	-21.86	2.98	90
	-	-	1.20	3.94	62.00	25	0.00315	-0.00052	1.68	1.11	3.042	-16.48	99.82	-7.38	44.72	90
Solid dish	-	-	0.60	1.97	70.00	45	0.00287	0.00075	1.74	1.10	0.760	6.11	23.37	2.74	10.47	35
	-	-	0.60	1.97	70.00	195	0.00379	-0.00044	1.74	1.10	0.760	-3.58	30.86	-1.61	13.83	35
	-	-	0.60	1.97	70.00	265	0.00058	0.00157	1.74	1.10	0.760	12.79	4.72	5.73	2.12	35
	-	-	0.60	1.97	70.00	355	0.00287	-0.00013	1.74	1.10	0.760	-1.02	23.37	-0.46	10.47	35
Sector	1.80	0.15	-	-	76.00	45	0.00305	0.00015	1.79	1.10	2.906	4.76	96.71	2.13	43.33	15
	1.80	0.15	-	-	76.00	175	0.00402	0.00004	1.79	1.10	2.906	1.27	127.47	0.57	57.10	15
	1.80	0.15	-	-	76.00	305	-0.00291	-0.00020	1.79	1.10	2.906	-6.34	-92.27	-2.84	-41.34	15
	1.80	0.15	-	-	76.00	5	0.00349	-0.00002	1.79	1.10	2.906	-0.63	110.66	-0.28	49.58	15

Tabel. 4.7 Perhitungan berat persegmen dan massa persegmen alternatif 1

SEGMEN	ELEMEN BATANG	JENIS PROFIL	BERAT Kg/m'	PANJANG m	BERAT Kg	BERAT Kg	MASSA (kg.dt2/m)
1	2	3	4	5	6	7	8
A	KAKI UTAMA	L160.160.19	45.100	40.100	1353.375		
	DIAG.UTAMA	L80.80.8	15.100	91.297	1378.585		
	REDUNDANT	L60.60.60	5.420	173.328	939.4378	4,488.63	457.557
	HOR. UTAMA	L70.70.7	7.380	33.184	244.8979		
	PLATFORM	L90.90.9	12.200	46.913	572.3386		
B	KAKI UTAMA	L160.160.19	45.100	24.060	812.025		
	DIAG.UTAMA	L80.80.8	15.100	57.504	868.3104		
	REDUNDANT	L60.60.60	5.420	130.914	709.5539	2,958.49	301.5785
	HOR. UTAMA	L70.70.7	7.380	30.712	226.6546		
	PLATFORM	L90.90.9	12.200	28.028	341.9416		
C	KAKI UTAMA	L160.160.19	45.100	24.06	812.025		
	DIAG.UTAMA	L80.80.8	15.100	60.09	907.359		
	REDUNDANT	L60.60.60	5.420	118.814	643.9719	2,932.53	298.9329
	HOR. UTAMA	L70.70.7	7.380	28.248	208.4702		
	PLATFORM	L90.90.9	12.200	29.566	360.7052		
D	KAKI UTAMA	L160.160.19	45.100	24.060	812.025		
	DIAG.UTAMA	L80.80.8	15.100	43.546	657.5446		
	REDUNDANT	L60.60.60	5.420	113.076	612.8719	2,556.88	260.6401
	HOR. UTAMA	L70.70.7	7.380	25.776	190.2269		
	PLATFORM	L90.90.9	12.200	23.296	284.2112		
E	KAKI UTAMA	L120.120.12	20.000	8.020	160.4		
	DIAG.UTAMA	L80.80.8	15.100	13.364	201.7964		
	REDUNDANT	L60.60.60	5.420	48.491	262.8212	1,660.14	169.2295
	HOR. UTAMA	L70.70.7	7.380	105.932	781.7782		
	PLATFORM	L90.90.9	12.200	20.766	253.3452		
F	KAKI UTAMA	L120.120.12	20.000	20.048	400.96		
	DIAG.UTAMA	L80.80.8	15.100	49.803	752.0253		
	REDUNDANT	L60.60.60	5.420	93.464	506.5749	2,071.34	211.1456
	HOR. UTAMA	L70.70.7	7.380	21.248	156.8102		
	PLATFORM	L90.90.9	12.200	20.899	254.9678		
G	KAKI UTAMA	L120.120.12	20.000	20.048	400.96		
	DIAG.UTAMA	L80.80.8	15.100	29.608	447.0808		
	REDUNDANT	L60.60.60	5.420	67.084	363.5953	1,588.93	161.9706
	HOR. UTAMA	L70.70.7	7.380	18.442	136.102		
	PLATFORM	L90.90.9	12.200	19.770	241.194		

Tabel. 4.7 Perhitungan berat persegmen dan massa persegmen alternatif 1

SEGMEN	ELEMEN BATANG	JENIS PROFIL	BERAT Kg/m'	PANJANG m	BERAT Kg	BERAT Kg	MASSA (kg.dt2/m)
1	2	3	4	5	6	7	8
H	KAKI UTAMA	L120.120.12	20.000	37.627	752.54		
	DIAG.UTAMA	L70.70.7	7.380	41.997	309.9379		
	REDUNDANT	L60.60.6	5.420	39.752	215.4558	1,643.88	167.5722
	HOR. UTAMA	L60.60.6	6.420	41.177	264.3563		
	PLATFORM	L70.70.7	7.380	13.766	101.5931		
I	KAKI UTAMA	L100.100.10	21.000	14.708	308.868		
	DIAG.UTAMA	L70.70.7	7.380	41.997	309.9379		
	REDUNDANT	L60.60.6	5.420	25.732	139.4674	1,134.61	115.6582
	HOR. UTAMA	L60.60.6	6.420	29.368	188.5426		
	PLATFORM	L70.70.7	7.380	25.446	187.7915		
J	KAKI UTAMA	L100.100.10	21.000	14.708	308.868		
	DIAG.UTAMA	L70.70.7	7.380	41.997	309.9379		
	REDUNDANT	L60.60.6	5.420	25.732	139.4674	1,134.61	115.6582
	HOR. UTAMA	L60.60.6	6.420	29.368	188.5426		
	PLATFORM	L70.70.7	7.380	25.446	187.7915		
K	KAKI UTAMA	L90.90.9	20.000	8.020	160.4		
	DIAG.UTAMA	L70.70.7	7.380	8.024	59.21712		
	REDUNDANT	L60.60.6	5.420	17.704	95.95568	725.81	73.98676
	HOR. UTAMA	L60.60.6	6.420	17.376	111.5539		
	PLATFORM	L70.70.7	7.380	40.472	298.6834		
L	KAKI UTAMA	L90.90.9	20.000	16.044	320.88		
	DIAG.UTAMA	L60.60.6	5.420	34.440	186.6648		
	DIAG.UTAMA	L70.70.7	8.380	40.374	338.3341		
	REDUNDANT	L60.60.6	5.420	15.480	83.9016	993.36	101.2604
	HOR. UTAMA	L60.60.6	6.420	9.904	63.58368		
	PLATFORM	L70.70.7	7.380				
M	KAKI UTAMA	L90.90.9	20.000	12.032	240.64		
	DIAG.UTAMA	L60.60.6	5.420	30.492	165.2666		
	REDUNDANT	L60.60.6	5.420	20.196	109.4623	674.80	68.78661
	HOR. UTAMA	L60.60.6	6.420	13.448	86.33616		
	PLATFORM	L70.70.7	7.380	9.904	73.09152		
N	KAKI UTAMA	L90.90.9	20.000	20.052	401.04		
	DIAG.UTAMA	L70.70.7	8.380	41.292	346.027		

Tabel. 4.7 Perhitungan berat persegmen dan massa persegmen alternatif 1

SEGMEN	ELEMEN BATANG	JENIS PROFIL	BERAT Kg/m'	PANJANG m	BERAT Kg	BERAT Kg	MASSA (kg.dt2/m)
1	2	3	4	5	6	7	8
	REDUNDANT	L60.60.6	5.420	42.463	230.1495	1,049.04	106.9361
	HOR. UTAMA	L60.60.6	6.420	11.188	71.82696		
	PLATFORM	L70.70.7	7.380	9.904	0		
O	KAKI UTAMA	L90.90.9	20.000	8.020	160.4		
	DIAG.UTAMA	L70.70.7	8.380	8.020	67.2076		
	REDUNDANT	L60.60.6	5.420	35.422	191.9872	699.29	71.2833
	HOR. UTAMA	L60.60.6	6.420	21.902	140.6108		
	PLATFORM	L70.70.7	7.380	18.846	139.0835		
P	KAKI UTAMA	L90.90.9	20.000	8.020	160.4		
	DIAG.UTAMA	L60.60.6	5.420	20.560	111.4352		
	REDUNDANT	L60.60.6	5.420	18.846	102.1453	407.36	41.52544
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
	PLATFORM	L70.70.7	7.380				
Q	KAKI UTAMA	L90.90.9	20.000	8.000	160		
	DIAG.UTAMA	L60.60.6	5.420	19.088	103.457	296.84	30.25902
	REDUNDANT	L60.60.6	5.420	0.000	0		
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
R	KAKI UTAMA	L60.60.6	5.420	8.000	43.36		
	DIAG.UTAMA	L60.60.6	5.420	19.088	103.457	180.20	18.36911
	REDUNDANT	L60.60.6	5.420	0.000	0		
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
	Berat Total					27,196.75	

Tabel. 4.8 Perhitungan berat persegmen dan massa persegmen alternatif 2

SEGMEN	ELEMEN BATANG	JENIS PROFIL	BERAT Kg/m'	PANJANG m	BERAT Kg	BERAT Kg	MASSA (kg.dt2/m)
1	2	3	4	5	6	7	8
A	KAKI UTAMA	L150.150.16	33.750	15.040	507.6		
	DIAG.UTAMA	L80.80.8	15.100	53.502	807.8802		
	REDUNDANT	L60.60.60	5.420	114.498	620.5792	2,575.23	262.5105
	HOR. UTAMA	L70.70.7	7.380	34.416	253.9901		
	PLATFORM	L90.90.9	12.200	31.572	385.1784		
B	KAKI UTAMA	L150.150.16	33.750	22.056	744.39		
	DIAG.UTAMA	L80.80.8	15.100	77.912	1176.471		
	REDUNDANT	L60.60.60	5.420	112.236	608.3191	2,858.66	291.4023
	HOR. UTAMA	L70.70.7	7.380	30.712	226.6546		
	PLATFORM	L90.90.9	12.200	8.428	102.8216		
C	KAKI UTAMA	L150.150.16	33.750	24.064	812.16		
	DIAG.UTAMA	L80.80.8	15.100	75.696	1143.01		
	REDUNDANT	L60.60.60	5.420	120.500	653.11	3,107.01	316.7188
	HOR. UTAMA	L70.70.7	7.380	28.400	209.592		
	PLATFORM	L90.90.9	12.200	23.700	289.14		
D	KAKI UTAMA	L150.150.16	33.750	24.060	812.025		
	DIAG.UTAMA	L80.80.8	15.100	55.752	841.8552		
	REDUNDANT	L60.60.60	5.420	96.980	525.6316	2,719.00	277.1657
	HOR. UTAMA	L70.70.7	7.380	30.490	225.0162		
	PLATFORM	L90.90.9	12.200	25.776	314.4672		
E	KAKI UTAMA	L120.120.12	20.000	18.048	360.96		
	DIAG.UTAMA	L80.80.8	15.100	51.096	771.5496		
	REDUNDANT	L60.60.60	5.420	83.038	450.066	2,117.53	215.8547
	HOR. UTAMA	L70.70.7	7.380	24.544	181.1347		
	PLATFORM	L90.90.9	12.200	29.002	353.8244		
F	KAKI UTAMA	L120.120.12	20.000	18.048	360.96		
	DIAG.UTAMA	L80.80.8	15.100	60.936	920.1336		
	REDUNDANT	L60.60.60	5.420	80.168	434.5106	2,177.78	221.996
	HOR. UTAMA	L70.70.7	7.380	21.248	156.8102		
	PLATFORM	L90.90.9	12.200	25.030	305.366		
G	KAKI UTAMA	L120.120.12	20.000	15.036	300.72		
	DIAG.UTAMA	L80.80.8	15.100	42.344	639.3944		
	REDUNDANT	L60.60.60	5.420	62.782	340.2784	1,719.78	175.3085
	HOR. UTAMA	L70.70.7	7.380	20.216	149.1941		
	PLATFORM	L90.90.9	12.200	23.786	290.1892		
H	KAKI UTAMA	L120.120.12	20.000	25.060	501.2		

Tabel. 4.8 Perhitungan berat persegmen dan massa persegmen alternatif 2

SEGMEN	ELEMEN BATANG	JENIS PROFIL	BERAT Kg/m'	PANJANG m	BERAT Kg	BERAT Kg	MASSA (kg.dt2/m)
1	2	3	4	5	6	7	8
	DIAG.UTAMA	L70.70.7	7.380	44.416	327.7901		
	REDUNDANT	L60.60.6	5.420	73.728	399.6058	1,514.47	154.3803
	HOR. UTAMA	L60.60.6	6.420	12.112	77.75904		
	PLATFORM	L70.70.7	7.380	28.200	208.116		
I	KAKI UTAMA	L100.100.10	21.000	15.036	315.756		
	DIAG.UTAMA	L70.70.7	7.380	38.248	282.2702		
	REDUNDANT	L60.60.6	5.420	44.752	242.5558	1,047.58	106.7875
	HOR. UTAMA	L60.60.6	6.420	16.104	103.3877		
	PLATFORM	L70.70.7	7.380	14.040	103.6152		
J	KAKI UTAMA	L100.100.10	21.000	16.040	336.84		
	DIAG.UTAMA	L70.70.7	7.380	35.408	261.311		
	REDUNDANT	L60.60.6	5.420	34.780	188.5076	957.64	97.61916
	HOR. UTAMA	L60.60.6	6.420	13.432	86.23344		
	PLATFORM	L70.70.7	7.380	11.484	84.75192		
K	KAKI UTAMA	L90.90.9	20.000	20.056	401.12		
	DIAG.UTAMA	L70.70.7	7.380	17.072	125.9914		
	REDUNDANT	L60.60.6	5.420	75.910	411.4322	1,098.39	111.9668
	HOR. UTAMA	L60.60.6	6.420	12.608	80.94336		
	PLATFORM	L70.70.7	7.380	10.692	78.90696		
L	KAKI UTAMA	L90.90.9	20.000	12.032	240.64		
	DIAG.UTAMA	L60.60.6	5.420	9.480	51.3816		
	DIAG.UTAMA	L70.70.7	8.380	17.072	143.0634		
	REDUNDANT	L60.60.6	5.420	29.888	161.993	699.41	71.29514
	HOR. UTAMA	L60.60.6	6.420	10.136	65.07312		
	PLATFORM	L70.70.7	7.380	5.048	37.25424		
M	KAKI UTAMA	L90.90.9	20.000	20.056	401.12		
	DIAG.UTAMA	L60.60.6	5.420	46.152	250.1438		
	REDUNDANT	L60.60.6	5.420	12.736	69.02912	858.47	87.50931
	HOR. UTAMA	L60.60.6	6.420	9.312	59.78304		
	PLATFORM	L70.70.7	7.380	10.622	78.39036		
					0		
N	KAKI UTAMA	L90.90.9	20.000	12.032	240.64		
	DIAG.UTAMA	L70.70.7	8.380	16.576	138.9069	458.37	46.72502
	REDUNDANT	L60.60.6	5.420	6.432	34.86144		
	HOR. UTAMA	L60.60.6	5.420	6.848	43.96416		
	PLATFORM	L70.70.7	7.380	7.642	56.39796		
O	KAKI UTAMA	L90.90.9	20.000	12.032	240.64		

Tabel. 4.8 Perhitungan berat persegmen dan massa persegmen alternatif 2

SEGMEN	ELEMEN BATANG	JENIS PROFIL	BERAT Kg/m'	PANJANG m	BERAT Kg	BERAT Kg	MASSA (kg.dt2/m)
1	2	3	4	5	6	7	8
	DIAG.UTAMA	L70.70.7	8.380	16.576	138.9069	458.37	46.72502
	REDUNDANT	L60.60.6	5.420	6.432	34.86144		
	HOR. UTAMA	L60.60.6	6.420	6.848	43.96416		
	PLATFORM	L70.70.7	7.380	7.642	56.39796		
P	KAKI UTAMA	L90.90.9	20.000	4.012	80.24		
	DIAG.UTAMA	L60.60.6	5.420	17.968	97.38656		0
	REDUNDANT	L60.60.6	5.420	3.008	16.30336	285.74	29.12701
	HOR. UTAMA	L60.60.6	6.420	14.300	91.806		
	PLATFORM	L70.70.7	7.380	4.392	32.41296		
					0		
Q	KAKI UTAMA	L90.90.9	20.000	8.000	160		
	DIAG.UTAMA	L60.60.6	5.420	19.088	103.457		
	REDUNDANT	L60.60.6	5.420	0.000	0	296.84	30.25902
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
R	KAKI UTAMA	L60.60.6	5.420	8.000	43.36		
	DIAG.UTAMA	L60.60.6	5.420	19.088	103.457		
	REDUNDANT	L60.60.6	5.420	0.000	0	180.20	18.36911
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
S	KAKI UTAMA	L60.60.6	5.420	8.000	43.36		
	DIAG.UTAMA	L60.60.6	5.420	19.088	103.457		
	REDUNDANT	L60.60.6	5.420	0.000	0	180.20	18.36911
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
	Berat Total					25,310.67	

Tabel. 4.9 Perhitungan berat persegmen dan massa persegmen alternatif 3

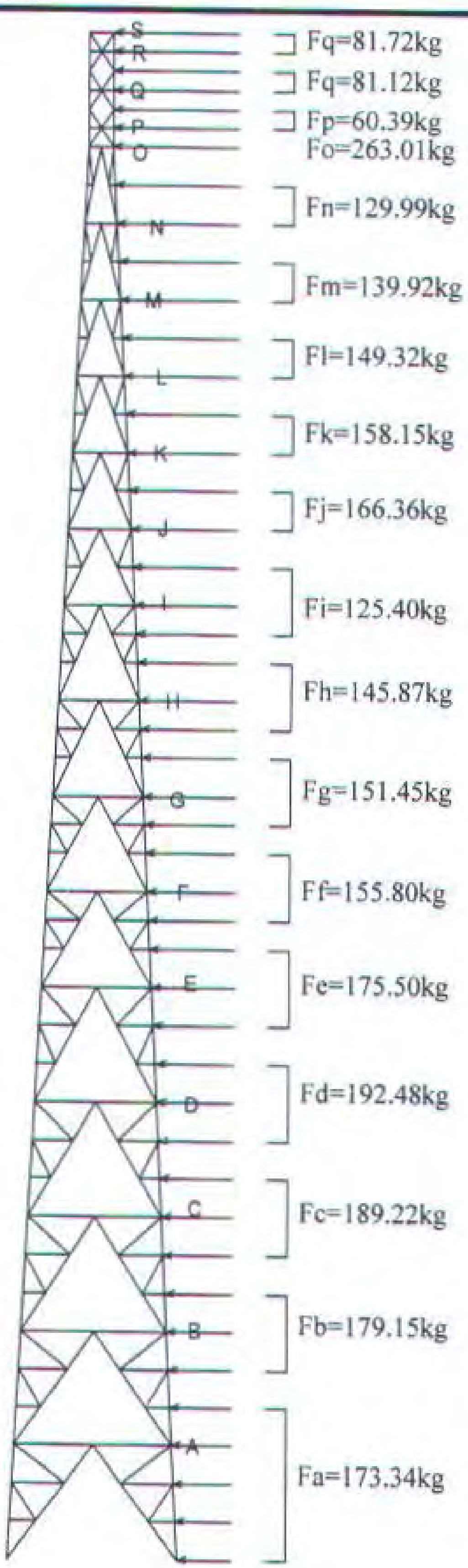
SEGMEN	ELEMEN BATANG	JENIS PROFIL	BERAT Kg/m'	PANJANG m	BERAT Kg	BERAT Kg	MASSA (kg.dt2/m)
1	2	3	4	5	6	7	8
A	KAKI UTAMA	L160.160.19	45.100	15.04	678.304		
	DIAG UTAMA	L80.80.8	15.100	83.88	1266.588		
	REDUNDANT	L60.60.60	5.420	209.996	1138.178	3,650.17	372.0866
	HOR. UTAMA	L70.70.7	7.380	33.136	244.5437		
	PLATFORM	L90.90.9	12.200	26.439	322.5558		
B	KAKI UTAMA	L160.160.19	45.100	24.064	1085.286		
	DIAG.UTAMA	L80.80.8	15.100	79.896	1206.43		
	REDUNDANT	L60.60.60	5.420	149.680	811.2656	3,629.35	369.9644
	HOR. UTAMA	L70.70.7	7.380	30.672	226.3594		
	PLATFORM	L90.90.9	12.200	24.591	300.0102		
C	KAKI UTAMA	L160.160.19	45.100	24.064	1085.286		
	DIAG.UTAMA	L80.80.8	15.100	56.072	846.6872		
	REDUNDANT	L60.60.60	5.420	78.476	425.3399	2,910.67	296.7048
	HOR. UTAMA	L70.70.7	7.380	36.523	269.5397		
	PLATFORM	L90.90.9	12.200	23.264	283.8208		
D	KAKI UTAMA	L160.160.19	33.750	24.060	812.025		
	DIAG.UTAMA	L80.80.8	15.100	55.752	841.8552		
	REDUNDANT	L60.60.60	5.420	96.980	525.6316	2,719.00	277.1657
	HOR. UTAMA	L70.70.7	7.380	30.490	225.0162		
	PLATFORM	L90.90.9	12.200	25.776	314.4672		
E	KAKI UTAMA	L120.120.12	20.000	24.064	481.28		
	DIAG.UTAMA	L80.80.8	15.100	54.808	827.6008		
	REDUNDANT	L60.60.60	5.420	84.64	458.7488	2,274.59	231.8649
	HOR. UTAMA	L70.70.7	7.380	23.28	171.8064		
	PLATFORM	L90.90.9	12.200	27.472	335.1584		
F	KAKI UTAMA	L120.120.12	20.000	20.048	400.96		
	DIAG.UTAMA	L80.80.8	15.100	52.656	795.1056		
	REDUNDANT	L60.60.60	5.420	73.58	398.8036	2,019.37	205.8478
	HOR. UTAMA	L70.70.7	7.380	21.244	156.7807		
	PLATFORM	L90.90.9	12.200	21.944	267.7168		
G	KAKI UTAMA	L120.120.12	20.000	52.656	1053.12		
	DIAG.UTAMA	L80.80.8	15.100	16.032	242.0832		
	REDUNDANT	L60.60.60	5.420	50.504	273.7317	2,264.67	230.8532
	HOR. UTAMA	L70.70.7	7.380	62.52	461.3976		
	PLATFORM	L90.90.9	12.200	19.208	234.3376		

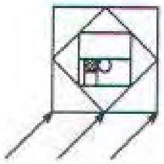
Tabel. 4.9 Perhitungan berat persegmen dan massa persegmen alternatif 3

SEGMEN	ELEMEN BATANG	JENIS PROFIL	BERAT Kg/m'	PANJANG m	BERAT Kg	BERAT Kg	MASSA (kg.dt2/m)
1	2	3	4	5	6	7	8
H	KAKI UTAMA	L120.120.12	20.000	52.656	1053.12		
	DIAG.UTAMA	L70.70.7	7.380	105.312	777.2026		
	REDUNDANT	L60.60.6	5.420	12.016	65.12672	2,585.64	263.5723
	HOR. UTAMA	L60.60.6	6.420	48.352	310.4198		
	PLATFORM	L70.70.7	7.380	51.46	379.7748		
I	KAKI UTAMA	L100.100.10	21.000	15.036	315.756		
	DIAG.UTAMA	L70.70.7	7.380	38.248	282.2702		
	REDUNDANT	L60.60.6	5.420	44.752	242.5558	1,047.58	106.7875
	HOR. UTAMA	L60.60.6	6.420	16.104	103.3877		
	PLATFORM	L70.70.7	7.380	14.040	103.6152		
J	KAKI UTAMA	L100.100.10	21.000	16.040	336.84		
	DIAG.UTAMA	L70.70.7	7.380	44.048	325.0742		
	REDUNDANT	L60.60.6	5.420	28.528	154.6218	949.86	96.82595
	HOR. UTAMA	L60.60.6	6.420	13.100	84.102		
	PLATFORM	L70.70.7	7.380	6.670	49.2246		
K	KAKI UTAMA	L90.90.9	20.000	16.040	320.8		
	DIAG.UTAMA	L70.70.7	7.380	41.896	309.1925		
	REDUNDANT	L60.60.6	5.420	28.528	154.6218	895.50	91.28411
	HOR. UTAMA	L60.60.6	6.420	11.064	71.03088		
	PLATFORM	L70.70.7	7.380	5.400	39.852		
L	KAKI UTAMA	L90.90.9	20.000	16.040	320.8		
	DIAG.UTAMA	L60.60.6	5.420	39.744	215.4125		
	DIAG.UTAMA	L70.70.7	8.380	28.528	239.0646		
	REDUNDANT	L60.60.6	5.420	9.028	48.93176	851.81	86.83128
	HOR. UTAMA	L60.60.6	6.420	4.300	27.606		
	PLATFORM	L70.70.7	7.380		0		
	Jumlah						
M	KAKI UTAMA	L90.90.9	20.000	16.040	320.8		
	DIAG.UTAMA	L60.60.6	5.420	37.592	203.7486		
	REDUNDANT	L60.60.6	5.420	28.528	154.6218	755.79	77.04312
	HOR. UTAMA	L60.60.6	6.420	6.992	44.88864		
	PLATFORM	L70.70.7	7.380	4.300	31.734		
					0		
N	KAKI UTAMA	L90.90.9	20.000	16.040	320.8		
	DIAG.UTAMA	L70.70.7	8.380	35.868	300.5738	783.08	79.82434
	REDUNDANT	L60.60.6	5.420	22.076	119.6519		

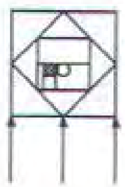
Tabel. 4.9 Perhitungan berat persegmen dan massa persegmen alternatif 3

SEGMEN	ELEMEN BATANG	JENIS PROFIL	BERAT Kg/m'	PANJANG m	BERAT Kg	BERAT Kg	MASSA (kg.dt2/m)
1	2	3	4	5	6	7	8
	HOR. UTAMA	L60.60.6	6.420	6.550	42.051		
	PLATFORM	L70.70.7	7.380	3.000	22.14		
O	KAKI UTAMA	L90.90.9	20.000	16.040	320.8		
	DIAG.UTAMA	L70.70.7	8.380	24.576	205.9469	644.81	65.73017
	REDUNDANT	L60.60.6	5.420	15.624	84.68208		
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
	PLATFORM	L70.70.7	7.380		0		
P	KAKI UTAMA	L90.90.9	20.000	8.000	160		
	DIAG.UTAMA	L60.60.6	5.420	19.088	103.457		0
	REDUNDANT	L60.60.6	5.420		0	296.84	30.25902
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
	PLATFORM	L70.70.7	7.380		0		
					0		
Q	KAKI UTAMA	L90.90.9	20.000	8.000	160		
	DIAG.UTAMA	L60.60.6	5.420	19.088	103.457		
	REDUNDANT	L60.60.6	5.420	0.000	0	296.84	30.25902
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
R	KAKI UTAMA	L60.60.6	5.420	8.000	43.36		
	DIAG.UTAMA	L60.60.6	5.420	19.088	103.457		
	REDUNDANT	L60.60.6	5.420	0.000	0	180.20	18.36911
	HOR. UTAMA	L60.60.6	6.420	5.200	33.384		
	Berat Total					28,755.79	



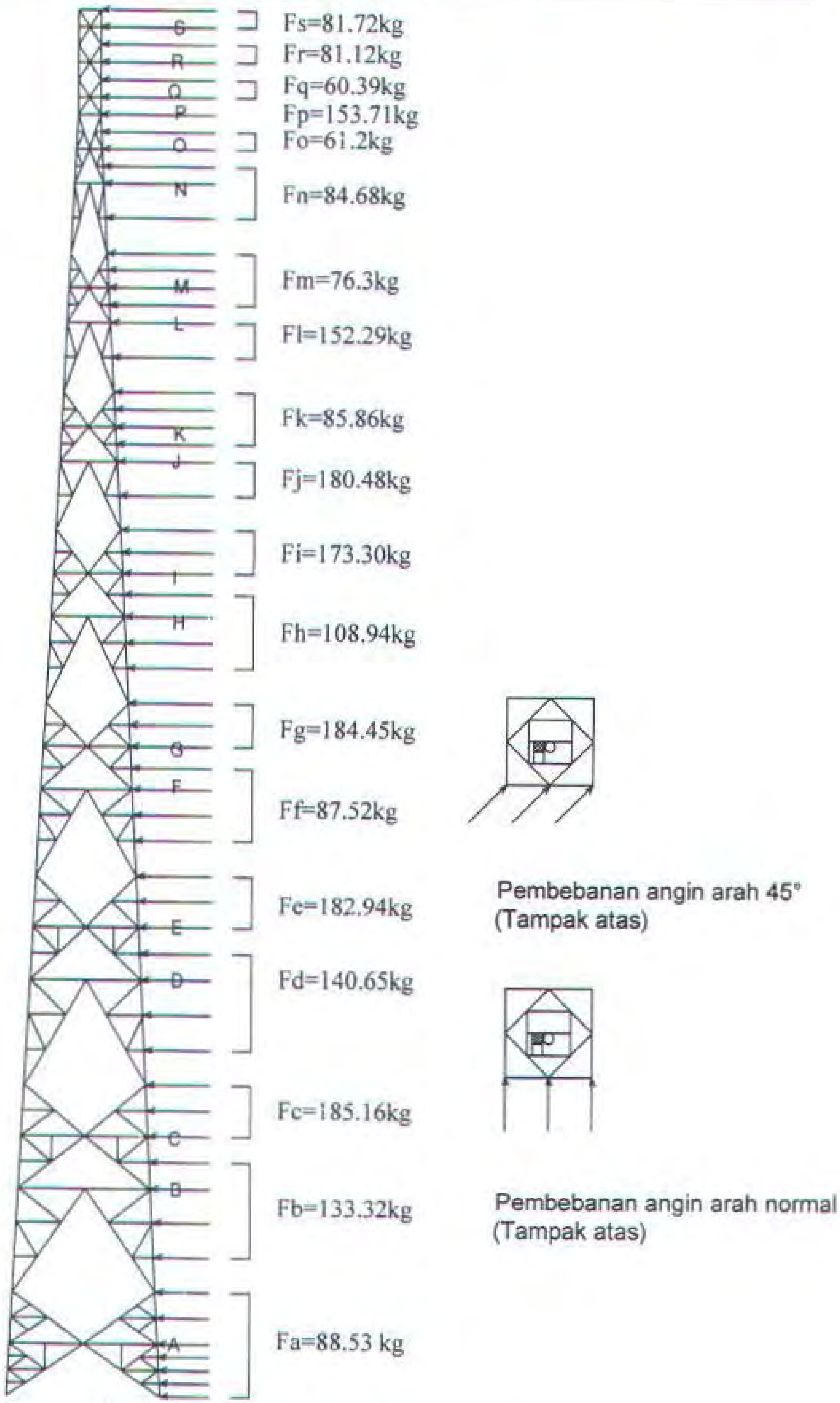


Pembebanan angin arah 45°
(Tampak atas)

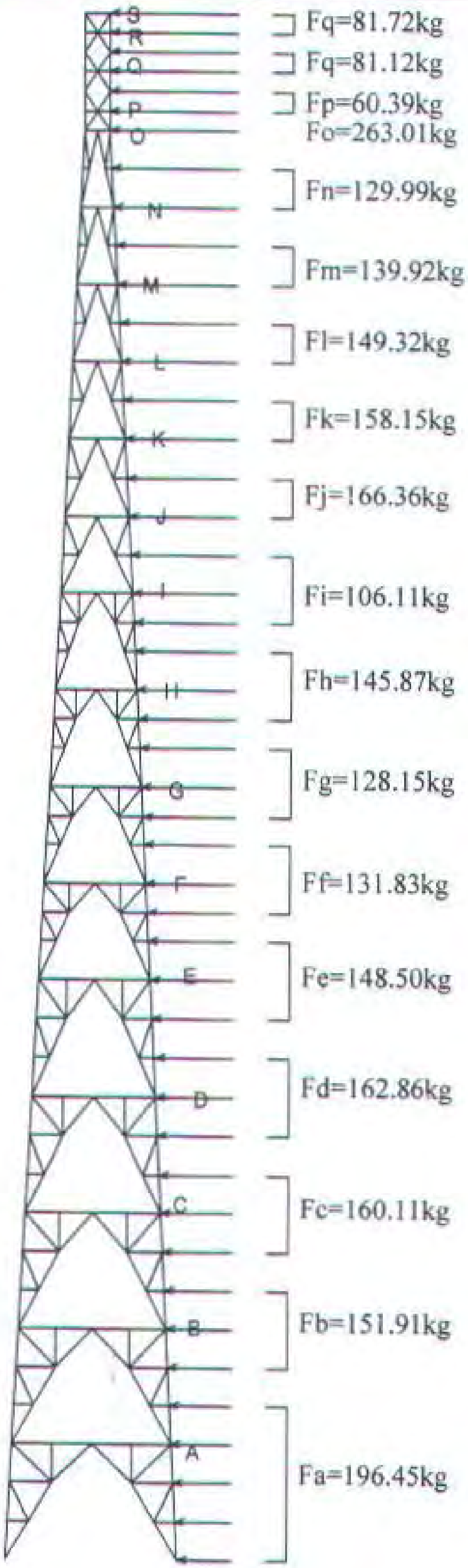


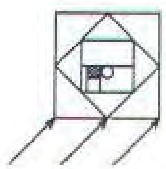
Pembebanan angin arah normal
(Tampak atas)

Gambar 4.1 Pembebanan angin tampak samping tower alternatif 1

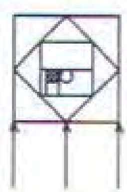


Gambar 4.3 Pembebanan angin tampak samping tower alternatif 2





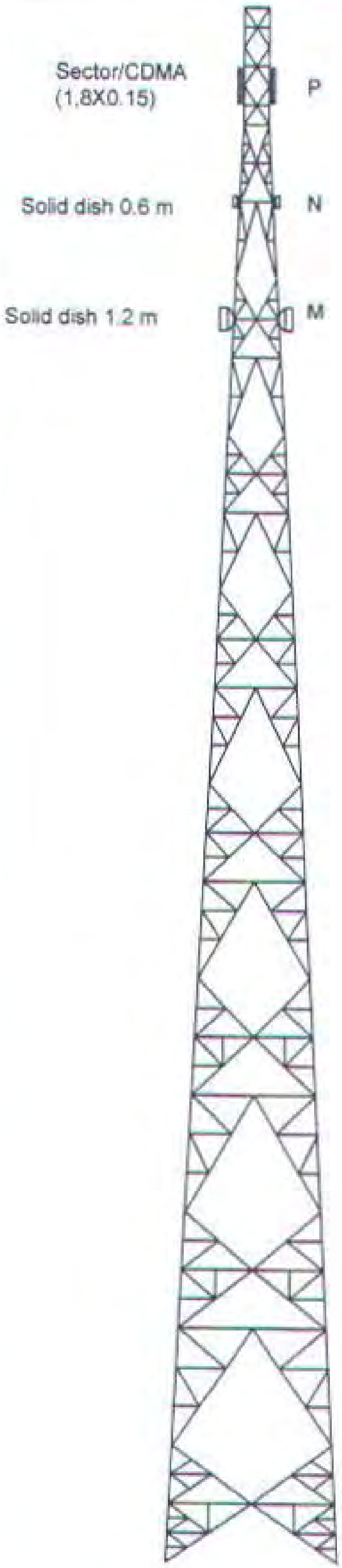
Pembebanan angin arah 45°
(Tampak atas)



Pembebanan angin arah normal
(Tampak atas)

Gambar 4.4Pembebanan angin tampak samping tower alternatif 3

TIPE ANTENA	BERAT	JUMLAH	LETAK	SUDUT ANTENA
Sector/CDMA (1,8X0.15)	15 kg	4 buah	+76 m	0°,110°,230°,340°
Solid dish 1.2 m	90kg	4 buah	+62 m	0°,150°,220°,310°
Solid dish 0.6 m	35kg	4 buah	+70 m	90°,130°,260°,320°



Gambar 4.4 Pembebanan antena tampak samping tower alternatif 2

BAB V
PERHITUNGAN STRUKTUR TOWER

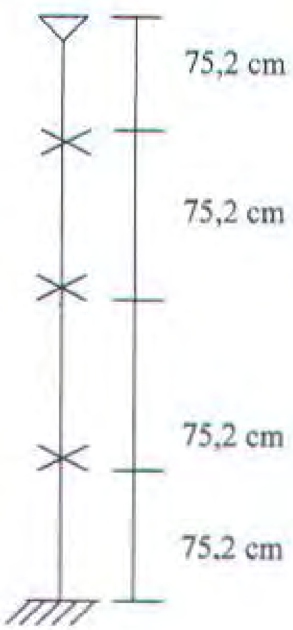
BAB V

PERHITUNGAN STRUKTUR TOWER

5.1. Perhitungan Struktur

Perhitungan Struktur tower ini menggunakan konsep LRFD dari Tata Cara Perencanaan Struktur Baja untuk Gedung tahun 2000. Dari hasil analisa struktur dengan SAP 2000 ternyata dihasilkan gaya aksial tekan pada frame-frame tower tersebut. Frame-frame tersebut harus mampu menahan gaya aksial yang bekerja, sehingga harus dilakukan kontrol perhitungan dengan menggunakan konsep LRFD.

Sebagai contoh perhitungan struktur tekan tersebut diambil batang/frame pada main member section A modifikasi alternatif 2, sebagai berikut :



Lx = Ly = L =75.2 cm

Profil L 150.150.16

Mutu baja BJ 37 ; Fy = 2400 kg/cm^2 =240 Mpa

Fu = 3700 kg/cm^2 =370 Mpa

A = 45,7cm^2

ix = iy = 4,56 cm

iξ = 5,74 cm

iη = 2,93 cm ....(i min)

b =150 mm

t =19 mm

$$\lambda r = \frac{200}{\sqrt{Fy}} = \frac{200}{\sqrt{240}} = 13$$

5.1.1. Kontrol Penampang (kelangsingan elemen penampang)

Sayap: $\frac{b}{t} = \frac{150}{16} = 9{,}38 < \lambda r$ ....(Ok)

5.1.2. Kontrol Komponen Struktur

Lk = Kc x L ,untuk struktur segi tiga Kc =1

$$\lambda = \frac{Lk}{i\min} = \frac{75{,}2}{2{,}93} = 25{,}67$$

$\lambda = 25{,}67 < 200$ ....(Ok)

$$\lambda c = \frac{\lambda}{\pi}\sqrt{\frac{Fy}{E}} = \frac{25{,}67}{\pi}\sqrt{\frac{2400}{2x10^6}} = 0.21$$

$\lambda c = 0{,}28$

$0{,}25<\lambda c=0{,}28<1{,}2 \Rightarrow \omega = \dfrac{1{,}43}{1{,}6-(0{,}67x\lambda c)}$ (bab 7.6.2 LRFD)

$$\text{Pn} = Ag\frac{Fy}{\omega} = 45{,}7x\frac{2400}{1{,}01} = 108594kg$$

ϕPn = 0,85 x 108594 = 91979 kg

Pu = 22,376 kg < ϕPn ....(ok)

5.1.3. Kontrol Defleksi

Berdasarkan EIA – 222F "Structural Standards for Steel Antena Towers And Antena Supporting Structures", struktur tower harus dilakukan kontrol terhadap defleksi akibat beban yang terjadi pada tower dengan rumus sebagai berikut;

Defleksi $\leq \dfrac{H}{100}$, dimana H adalah ketinggian tower dalam meter

<u>**Contoh perhitungan;**</u>

Pada tower alternatif 2 section S dengan kertinggian (H)= 79 m

Defleksi ijin = $\dfrac{79}{100} = 0{,}79m$ =790 mm

Defleksi actual ; ΔY = 459 mm < 790 mm....Ok

ΔX = 460 m < 790 m....Ok

5.1.4. Kontrol Sway / Goyangan

Selain kontrol terhadap defleksi struktur tower perlu juga dikontrol terhadap sway / goyangan. Sway adalah sudut yang di bentuk antara defleksi tiap segmen degan dengan tinggi segmen tersebut, dalam hal ini sway ijin struktur tower 0,5°. Perumusan sway adalah sebagai berikut;

Sway = arc tan $\Delta x,y / H$

dimana : $\Delta x,y$ = defleksi tiap segmen (di ambil yang terbesar dari arah x,y)

H = Ketinggian tower

Contoh perhitungan;

Pada tower alternatif 2 section S dengan kertinggian H = 79 m, Δ = 0,001

Sway aktual = arc tan Δ / H

= arc tan 460/ 79000 = 0,35° <0,5°.....Ok

5.1.5. Kontrol Twist/puntir

Twist adalah rotasi yang terbentuk pada tiap segemen arah horizontal, dalam hal ini twist ijin struktur tower 0,5°.

Contoh perhitungan;

Pada tower alternatif 2 section S dengan kertinggian H = 79 m, Twist = 0,3° < 0,5°...Ok

Untuk perhitungan selanjutnya dapat ditabelkan ,dapat dilihat di table 5.10,5.11 dan

5.2. Pemilihan Alternatif Desain yang Paling Ekonomis

Dalam perencanaan struktur baja, struktur harus didesain :

- **Aman**

  Suatu struktur baja tentu saja harus direncanakan cukup kuat untuk memikul beban yang bekerja padanya. Juga harus diperhitungkan agar lendutan tidak besar ,sehingga dapat menjamin rasa aman.

- **Ekonomis**

  Selain harus kuat dan aman ,struktur baja harus direncanakan dengan biaya semurah – murahnya.

  Murah disini dapat ditinjau dari dua segi,yaitu:

  - Segi bahan : Pemilihan profil sedemikian rupa sehingga di dapat struktur yang seringan mungkin. Harga bahan baja dihitung dengan satuan (Rp/Kg).
  - Segi ongkos : Pemilihan metode pelaksanaan yang mudah dan cepat. Juga pemilihan sambungan yang sederhana ,sehingga pengerjaan cepat. Ongkos dihitung dengan satuan (Rp/Kg).

Pemilihan alternatif desain yang paling ekonomis dalam tugas akhir ini hanya memperhitungkan ekonomis dari segi bahan saja. Jadi diantara tiga macam alternatif desain tersebut diambil satu yang mempunyai berat sendiri yang paling ringan. Dari output sap didapat reaksi akibat berat sendiri sebagai berikut:

a. Desain semula mempunyai berat sendiri 32920 kg

b. Desain alternatif 1 mempunyai berat sendiri 27196 kg

c. Desain alternatif 2 mempunyai berat sendiri 25310 kg

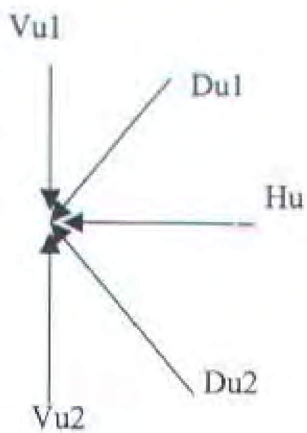
d. Desain alternatif mempunyai berat sendiri 28755 kg

Diantara ketiga alternatif ,yang mempunyai berat terkecil adalah alternatif 2 (dua) sehingga untuk perhitungan selanjutnya hanya membahas struktur tower alternatif 2 (dua), sebagai desain yang mempunyai berat paling ringan. Perhitungan selanjutnya yaitu perhitungan sambungan dan perhitungan pondasi .

5.3. Perhitungan Sambungan

Sambungan Tipe A

Contoh perhitungan sambungan baut batang tepi menerus pada segmen A alternatif 2 dengan ketinggian 3 meter:



Vu1=14311 kg (L200.200.20)
Vu2= 14703 kg (L200.200.20)
Du1= 296 kg (L60.60.6)
Du2= 270 Kg (L60.60.6)
Hu = 0 kg (L70.70.7)

Baja BJ 37
Fy = 2400 kg/cm^2
Fu = 3700 kg/cm^2

Direncanakan : ϕ baut = 16 mm
Tebal pelat = 6 mm

Kontrol kekuatan baut tipe tumpu:

Kuat geser ϕ Rn = 0,75 x (0,5Fu) x nxAb n = jumlah bidang geser = 1
= 0,75 x (0,5x3700) x 1 x2,01
= 2789 kg ....(menentukan)

Kuat tumpu ϕ Rn = 0,75 x (2,4dxtpxFu)
= 0,75 x (2,4x1,6x0,6x3700)
= 6394 kg

Banyaknya baut :

$$n1 = \frac{Du1}{\phi Rn} = \frac{2000}{2789} = 0{,}1 \approx 2baut$$

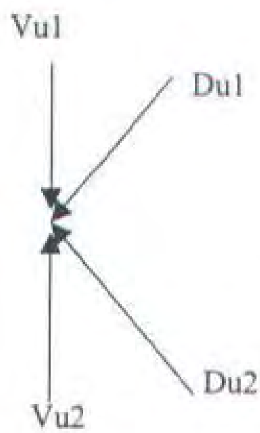
$$n2 = \frac{Du2}{\phi Rn} = \frac{270}{2789} = 0{,}09 \approx 2baut$$

$$n3 = \frac{Hu}{\phi Rn} = \frac{0}{2789} = 0 \approx 2baut$$

$$n4 = \frac{Vu1 + Vu2}{\phi Rn} = \frac{14703 - 14311}{2789} = 0{,}14 \approx 2baut$$

Sambungan Tipe B

Contoh perhitungan sambungan baut batang tepi terputus pada segmen A alternatif 2 dengan ketinggian 6 meter:



Vu1=3436 kg (150.150.15)

Vu2=14227 kg (L150.150.15)

Du1= 4131 kg (L80.80.8)

Du2= 2444 Kg (L80.80.8)

$Fy = 2400 \text{ kg/cm}^2$
$Fu = 3700 \text{ kg/cm}^2$

Direncanakan : ϕ baut = 16 mm
Tebal pelat = 6 mm

Kuat geser ϕ Rn = 0,75 x (0,5Fu) x n x Ab
= 0,75 x (0,5x3700) x 1 x 2,01
= 2789 kg ....(menentukan)

Kuat tumpu ϕ Rn = 0,75 x (2,4dxtpxFu)
= 0,75 x (2,4x1,6x0,6x3700)
= 6394 kg

Banyaknya baut :

$$n1 = \frac{Du1}{\phi Rn} = \frac{4131}{2789} = 1{,}4 \approx 2baut$$

$$n2 = \frac{Du2}{\phi Rn} = \frac{2444}{2789} = 0{,}8 \approx 2baut$$

$$n3 = \frac{Vu1}{\phi Rn} = \frac{3436}{2789} = 3{,}6 \approx 6baut$$

$$n3 = \frac{Vu2}{\phi Rn} = \frac{14227}{2789} = 6baut$$

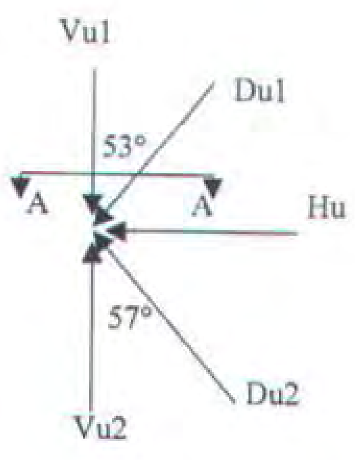
Untuk perhitungan selanjutkan baik itu sambungan batang tepi menerus maupun sambungan batang tepi terputus dapat di table 5.13

5.3.1. Kontrol Kekuatan Pelat Simpul

5.3.1.1. Kontrol kekuatan pelat simpul batang tepi menerus

Sambungan Tipe A

Contoh perhitungan kekuatan pelar simpul batang tepi menerus pada segmen A alternatif 2 dengan ketinggian 3 meter:



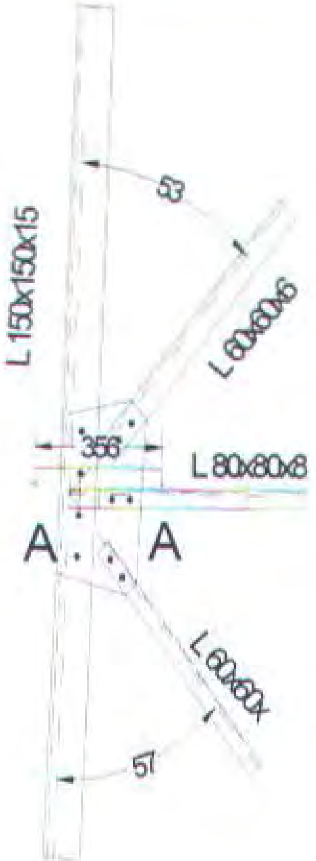
Vu1=14311 kg (L200.200.20)

Vu2= 14703 kg (L200.200.20)

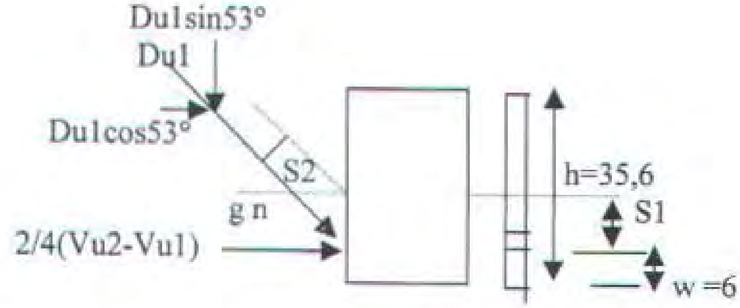
Du1= 296 kg (L60.60.6)

Du2= 270 Kg (L60.60.6)

Hu= 0 kg (L70.70.7)



Gambar.5.1. Sambungan batang tepi menerus pelat simpul A



S1 = ½ h –w = ½.35,6-6 = 7 cm

S2 = 7sin53° = 5,6 cm

Nut = 1/2 (Vu2-Vu1) + Du1 cos53°
=1/2 (14703-14311) + 270 cos53°

= 364 kg

Mut = 1/2 (Vu2-Vu1)xS1 + Du1 x S2

= 1/2 (14703-14311)x7 + (296 x 5,6)
= 3030 kg cm

Vu = Du1 sin 53° = 296 sin 53° = 234 kg

Ag = txh = 0,6 x 34 = 20,4 cm^2

An = txh –Alub = 20,4 – (1,6x0,6) = 19,44 cm^2

Z = ¼ txh^2 – Alub x S1
= ¼ 0,6x34^2 – 0,96 x 7
= 166,7 cm^3

ϕt Nnt = 0,9 x fy x Ag = 0,9 x 2400 x 13,8 = 29808 kg ....(menentukan)
= 0,75 x fu x An = 0,75 x 3700 x 12,84 = 35631 kg

ϕb Mn = 0,9 x Z x fy = 0,9x 166,7 x 2400 = 360072kg

ϕv Vn = 0,75 x (0,6 An x Fu) =0,75 (0,6x12,84x3700) = 21379 kg

Kontrol kekuatan :

$$\left[\left(\frac{Nut}{\phi Nnt}\right)+\left(\frac{Mut}{\phi b Mn}\right)\right]^2+\left(\frac{Vu}{\phi v Vn}\right)^2 \leq 1$$

$$\left[\left(\frac{364}{29808}\right)+\left(\frac{3030}{158954}\right)\right]^2+\left(\frac{234}{21379}\right)^2 \leq 1$$

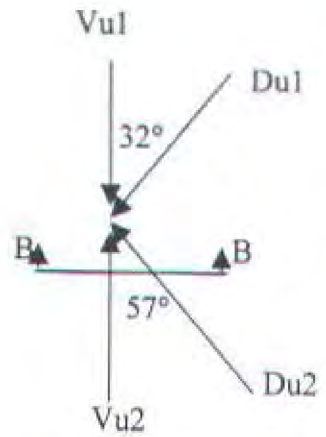
$$(0{,}01+0{,}02)^2+0{,}01^2 \leq 1$$

0,001 ≤ 1 .... (Ok !)

5.3.1.2 Kontrol kekuatan pelat simpul batang tepi terputus

Sambungan Tipe B

Contoh perhitungan sambungan baut batang tepi terputus pada segmen A alternatif 2 dengan ketinggian 6 meter:

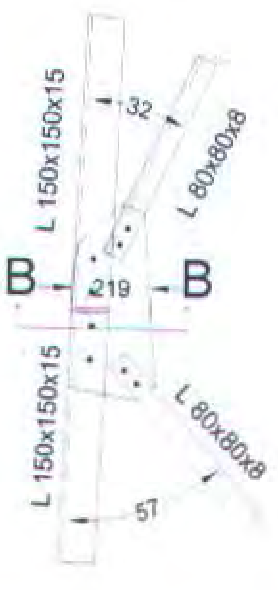


Vu1=3435 kg (L150.150.15)

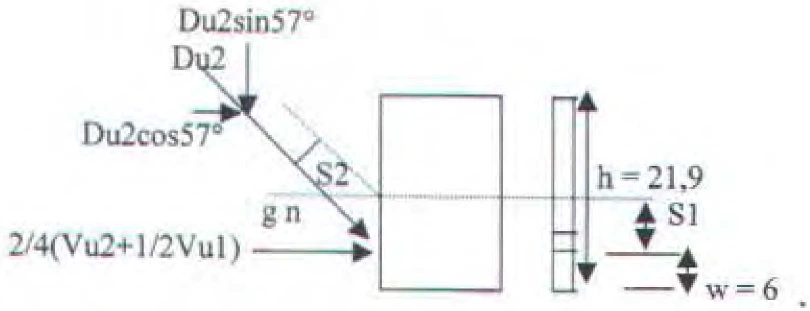
Vu2= 14227 kg (L150.150.15)

Du1= 4122 kg (L80.80.8)

Du2= 2444 Kg (L80.80.8)



Gambar 5.2.Sambungan batang tepi terputus pelat simpul B



$S1 = ½ h - w = ½\ 21,9 - 6 = 5$ cm

$S2 = 5 \sin 57° = 4,2$ cm

$Nut = 2/4\ (Vu2+1/2Vu1) + Du2 \cos 57°$
$= 2/4\ (14227+1/2x3435) + 2444 \cos 57°$
$= 9304$ kg

$Mut = 2/4\ (Vu2+1/2xVu_1)xS1 + Du2 \times S2$

$= 2/4\ (14227+1/2x3435)x5 + 2444 \times 4,2$
$= 45834$ kg cm

$Vut = Du_1 \sin 57° = 4122 \sin 57° = 3458$ kg

$Ag = txh = 0,6 \times 21,9 = 13,2\ cm^2$

$An = txh - Alub = 13,2 - (1,6x0,6) = 12,3\ cm^2$

$Z = ¼\ txh^2 - Alub \times jarak$
$= ¼\ 0,6x21,9^2 - 0,96 \times 6$
$= 66,2\ cm^3$

$\phi t\ Nnt = 0,9 \times fy \times Ag = 0,9 \times 2400 \times 13,8 = 29808$ kg ....(menentukan)
$= 0,75 \times fu \times An = 0,75 \times 3700 \times 12,84 = 35631$ kg

$\phi b\ Mn = 0,9 \times Z \times fy = 0,9x\ 73,59x\ 2400 = 158954$ kg

$\phi v\ Vn = 0,75 \times (0,6\ An \times Fu) = 0,75\ (0,6x12,84x3700) = 21379$ kg

Kontrol kekuatan :

$$\left[\left(\frac{Nut}{\phi Nnt}\right)+\left(\frac{Mut}{\phi bMn}\right)\right]^2+\left(\frac{Vut}{\phi vVn}\right)^2 \leq 1$$

$$\left[\left(\frac{9304}{29808}\right)+\left(\frac{45834}{158954}\right)\right]^2+\left(\frac{3458}{21379}\right)^2 \leq 1$$

$$(0,31+0,29)^2+0,03^2 \leq 1$$

$0,36 \leq 1$ .... (Ok !)

TABEL 5.1.KONTROL TEGANGAN PADA STRUKTUR TOWER ALTERNATIF 1

Fy = 240 Mpa
Fu = 370 Mpa
Es = 2000000 Mpa

Segmen	Nama Batang	Profil	Frame	Pu (kg) (kg)	A (cm2)	ix = iy (cm)	$i\xi$ (cm)	$i\eta$ (cm)	b (mm)	t (mm)	b/t	λr	Kontrol b/t < λr	Lk (cm)	λ (Lk/i) (cm)	Kontrol λ <200	λc	ω	ϕPn (kg)	Kontrol ϕPn >Pu
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
A	KAKI UTAMA	L160.160.19	55	46,594	57.5	4.84	6.1	3.12	160	19	8.42	12.91	Ok	200	64.10	Ok	0.71	1.27	92,492	Ok
B	KAKI UTAMA	L160.160.19	27	39,086	57.5	4.84	6.1	3.12	160	19	8.42	12.91	Ok	200	64.10	Ok	0.71	1.27	92,492	Ok
C	KAKI UTAMA	L160.160.19	70	32,191	57.5	4.84	6.1	3.12	160	19	8.42	12.91	Ok	200	64.10	Ok	0.71	1.27	92,492	Ok
D	KAKI UTAMA	L160.160.19	30	26,003	57.5	4.84	6.1	3.12	160	19	8.42	12.91	Ok	200	64.10	Ok	0.71	1.27	92,492	Ok
E	KAKI UTAMA	L120.120.12	82	20,581	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	200	85.47	Ok	0.94	1.47	41,102	Ok
F	KAKI UTAMA	L120.120.12	33	16,711	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	167	71.37	Ok	0.79	1.33	45,505	Ok
G	KAKI UTAMA	L120.120.12	91	2,894	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	167	71.37	Ok	0.79	1.33	45,505	Ok
H	KAKI UTAMA	L120.120.12	36	5,906	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	167	71.37	Ok	0.79	1.33	45,505	Ok
I	KAKI UTAMA	L100.100.10	1344	398	21.2	3.36	4.23	1.95	100	10	10.00	12.91	Ok	167	85.64	Ok	0.94	1.48	29,301	Ok
J	KAKI UTAMA	L100.100.10	1327	3,920	21.2	3.36	4.23	1.95	100	10	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	25,528	Ok
K	KAKI UTAMA	L90.90.9	1356	728	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
L	KAKI UTAMA	L90.90.9	1329	1,393	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
M	KAKI UTAMA	L90.90.9	1361	1,425	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
N	KAKI UTAMA	L90.90.9	1311	1,521	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
O	KAKI UTAMA	L90.90.9	1604	396	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
P	KAKI UTAMA	L90.90.9	180	1,220	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
Q	KAKI UTAMA	L90.90.9	179	704	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
R	KAKI UTAMA	L60.60.6	177	364	6.91	1.82	2.2	1.17	60	6	10.00	12.91	Ok	100	85.47	Ok	0.94	1.47	9,563	Ok
S	KAKI UTAMA	L60.60.6	173	355	6.91	1.82	2.2	1.17	60	6	10.00	12.91	Ok	100	85.47	Ok	0.94	1.47	9,563	Ok

TABEL 5.2 KONTROL TEGANGAN PADA STRUKTUR TOWER ALTERNATIF 2

Fy = 240 Mpa
Fu = 370 Mpa
Es = 2000000 Mpa

Segmen	Nama Batang	Profil	Frame	Pu (kg) (kg)	A (cm2)	ix = iy (cm)	iξ (cm)	iη (cm)	b (mm)	t (mm)	b/t	λr	Kontrol b/t < λr	Lk (cm)	λ (Lk/i) (cm)	Kontrol λ <200	λc	ω	φPn (kg)	Kontrol φPn >Pu
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
A	KAKI UTAMA	L150.150.16	2722	14,704	45.7	4.56	5.74	2.93	150	16	9.38	12.91	Ok	75	25.67	Ok	0.28	1.01	91,979	Ok
B	KAKI UTAMA	L150.150.16	2727	9,211	45.7	4.56	5.74	2.93	150	16	9.38	12.91	Ok	200	68.26	Ok	0.75	1.30	71,514	Ok
C	KAKI UTAMA	L150.150.16	2729	6,819	45.7	4.56	5.74	2.93	150	16	9.38	12.91	Ok	150	51.19	Ok	0.56	1.17	79,713	Ok
D	KAKI UTAMA	L150.150.16	2734	4,050	45.7	4.56	5.74	2.93	150	16	9.38	12.91	Ok	200	68.26	Ok	0.75	1.30	71,514	Ok
E	KAKI UTAMA	L120.120.12	2736	3,333	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	150	64.10	Ok	0.71	1.27	47,774	Ok
F	KAKI UTAMA	L120.120.12	2741	5,674	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	167	71.37	Ok	0.79	1.33	45,505	Ok
G	KAKI UTAMA	L120.120.12	2740	5,499	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	167	71.37	Ok	0.79	1.33	45,505	Ok
H	KAKI UTAMA	L120.120.12	2747	1,956	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	167	71.37	Ok	0.79	1.33	45,505	Ok
I	KAKI UTAMA	L100.100.10	2748	4,219	21.2	3.36	4.23	1.95	100	10	10.00	12.91	Ok	125	64.10	Ok	0.71	1.27	34,101	Ok
J	KAKI UTAMA	L100.100.10	2750	3,350	21.2	3.36	4.23	1.95	100	10	10.00	12.91	Ok	125	64.10	Ok	0.71	1.27	34,101	Ok
K	KAKI UTAMA	L90.90.9	2755	3,144	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
L	KAKI UTAMA	L90.90.9	2756	3,113	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
M	KAKI UTAMA	L90.90.9	2758	2,972	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
N	KAKI UTAMA	L90.90.9	2762	504	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
O	KAKI UTAMA	L90.90.9	2761	485	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
P	KAKI UTAMA	L90.90.9	2765	1,856	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
Q	KAKI UTAMA	L90.90.9	1814	657	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
R	KAKI UTAMA	L60.60.6	1812	154	6.91	1.82	2.2	1.17	60	6	10.00	12.91	Ok	100	85.47	Ok	0.94	1.47	9,563	Ok
S	KAKI UTAMA	L60.60.6	1810	118	6.91	1.82	2.2	1.17	60	6	10.00	12.91	Ok	100	85.47	Ok	0.94	1.47	9,563	Ok

TABEL 5.3 KONTROL TEGANGAN PADA STRUKTUR TOWER ALTERNATIF 3

Fy = 240 Mpa
Fu = 370 Mpa
Es = 2000000 Mpa

Segmen	Nama Batang	Profil	Frame	Pu (kg) (kg)	A (cm2)	ix = iy (cm)	iξ (cm)	iη (cm)	b (mm)	t (mm)	b/t	λr	Kontrol b/t < λr	Lk (cm)	λ (Lk/i) (cm)	Kontrol λ <200	λc	ω	φPn (kg)	Kontrol φPn >Pu
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
A	KAKI UTAMA	L160.160.19	226	46,907	57.5	4.84	6.1	3.12	160	19	8.42	12.91	Ok	200	64.10	Ok	0.71	1.27	92,492	Ok
B	KAKI UTAMA	L160.160.19	198	39,399	57.5	4.84	6.1	3.12	160	19	8.42	12.91	Ok	200	64.10	Ok	0.71	1.27	92,492	Ok
C	KAKI UTAMA	L160.160.19	241	32,504	57.5	4.84	6.1	3.12	160	19	8.42	12.91	Ok	200	64.10	Ok	0.71	1.27	92,492	Ok
D	KAKI UTAMA	L160.160.19	201	26,316	57.5	4.84	6.1	3.12	160	19	8.42	12.91	Ok	200	64.10	Ok	0.71	1.27	92,492	Ok
E	KAKI UTAMA	L120.120.12	253	20,894	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	200	85.47	Ok	0.94	1.47	41,102	Ok
F	KAKI UTAMA	L120.120.12	204	17,024	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	167	71.37	Ok	0.79	1.33	45,505	Ok
G	KAKI UTAMA	L120.120.12	262	3,207	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	167	71.37	Ok	0.79	1.33	45,505	Ok
H	KAKI UTAMA	L120.120.12	207	6,219	29.7	3.64	4.59	2.34	120	12	10.00	12.91	Ok	167	71.37	Ok	0.79	1.33	45,505	Ok
I	KAKI UTAMA	L100.100.10	1515	711	21.2	3.36	4.23	1.95	100	10	10.00	12.91	Ok	167	85.64	Ok	0.94	1.48	29,301	Ok
J	KAKI UTAMA	L100.100.10	1498	4,233	21.2	3.36	4.23	1.95	100	10	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	25,528	Ok
K	KAKI UTAMA	L90.90.9	1527	1,041	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
L	KAKI UTAMA	L90.90.9	1500	1,706	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
M	KAKI UTAMA	L90.90.9	1532	1,736	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
N	KAKI UTAMA	L90.90.9	1482	1,634	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
O	KAKI UTAMA	L90.90.9	1775	709	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	200	102.56	Ok	1.13	1.69	18,665	Ok
P	KAKI UTAMA	L90.90.9	351	1,533	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
Q	KAKI UTAMA	L90.90.9	350	1,017	15.5	2.74	3.82	1.95	90	9	10.00	12.91	Ok	100	51.28	Ok	0.56	1.17	27,022	Ok
R	KAKI UTAMA	L60.60.6	346	677	6.91	1.82	2.2	1.17	60	6	10.00	12.91	Ok	100	85.47	Ok	0.94	1.47	9,563	Ok
S	KAKI UTAMA	L60.60.6	344	668	6.91	1.82	2.2	1.17	60	6	10.00	12.91	Ok	100	85.47	Ok	0.94	1.47	9,563	Ok

Tabel 5.4 Tabel defleksi desain Alternatif 1

Section	Elevasi (m)	No. Joint	Defleksi Aktual X (mm)	Defleksi Aktual Y (mm)	Defleksi max (H/100) (mm)	Kontral Defleksi X	Kontral Defleksi Y
1	2	3	4	5	6	7	8
A	3.00	33	14	13	30	Ok	Ok
B	9.00	36	35	34	90	Ok	Ok
C	15.00	37	57	56	150	Ok	Ok
D	21.00	40	56	55	210	Ok	Ok
E	27.00	41	67	66	270	Ok	Ok
F	32.50	44	86	85	325	Ok	Ok
G	37.50	45	100	99	375	Ok	Ok
H	42.50	48	70	69	425	Ok	Ok
I	47.50	219	58	57	475	Ok	Ok
J	52.00	235	153	152	520	Ok	Ok
K	56.00	251	193	192	560	Ok	Ok
L	60.00	266	223	222	600	Ok	Ok
M	64.00	279	243	242	640	Ok	Ok
N	68.00	298	323	322	680	Ok	Ok
O	72.00	190	353	352	720	Ok	Ok
P	74.00	189	363	362	740	Ok	Ok
Q	75.00	187	417	416	750	Ok	Ok
R	77.00	185	433	432	770	Ok	Ok
S	79.00	184	463	462	790	Ok	Ok
Top	80.00	182	493	492	800	Ok	Ok

Keterangan:

1.Nilai defleksi arah X dan Y didapat dari analisa komputer

Tabel 5.5 Tabel defleksi desain Alternatif 2

Section	Elevasi (m)	No. Joint	Defleksi Aktual X (mm)	Defleksi Aktual Y (mm)	Defleksi max (H/100) (mm)	Kontral Defleksi X	Kontral Defleksi Y
1	2	3	4	5	6	7	8
A	3.00	98	11	10	30	Ok	Ok
B	9.00	103	32	31	90	Ok	Ok
C	15.00	105	54	53	150	Ok	Ok
D	21.00	110	53	52	210	Ok	Ok
E	27.00	112	64	63	270	Ok	Ok
F	32.50	115	83	82	325	Ok	Ok
G	37.50	117	97	96	375	Ok	Ok
H	42.50	124	67	66	425	Ok	Ok
I	47.50	314	55	54	475	Ok	Ok
J	52.00	342	150	149	520	Ok	Ok
K	56.00	377	190	189	560	Ok	Ok
L	60.00	405	220	219	600	Ok	Ok
M	64.00	441	240	239	640	Ok	Ok
N	68.00	490	320	319	680	Ok	Ok
O	72.00	463	350	349	720	Ok	Ok
P	74.00	223	360	359	740	Ok	Ok
Q	75.00	232	414	413	750	Ok	Ok
R	77.00	230	430	429	770	Ok	Ok
S	79.00	228	460	459	790	Ok	Ok
Top	80.00	227	490	489	800	Ok	Ok

Keterangan:

1.Nilai defleksi arah X dan Y didapat dari analisa komputer

Tabel 5.6 Tabel defleksi desain Alternatif 3

Section	Elevasi (m)	No. Joint	Defleksi Aktual X (mm)	Defleksi Aktual Y (mm)	Defleksi max (H/100) (mm)	Kontral Defleksi X	Kontral Defleksi Y
1	2	3	4	5	6	7	8
A	3.00	94	20	19	30	Ok	Ok
B	9.00	95	41	40	90	Ok	Ok
C	15.00	100	63	62	150	Ok	Ok
D	21.00	101	62	61	210	Ok	Ok
E	27.00	104	73	72	270	·Ok	Ok
F	32.50	103	92	91	325	Ok	Ok
G	37.50	85	106	105	375	Ok	Ok
H	42.50	111	76	75	425	Ok	Ok
I	47.50	112	64	63	475	Ok	Ok
J	52.00	409	159	158	520	Ok	Ok
K	56.00	405	199	198	560	Ok	Ok
L	60.00	411	229	228	600	Ok	Ok
M	64.00	441	249	248	640	Ok	Ok
N	68.00	211	329	328	680	Ok	Ok
O	72.00	206	359	358	720	Ok	Ok
P	74.00	204	369	368	740	Ok	Ok
Q	75.00	642	423	422	750	Ok	Ok
R	77.00	644	439	438	770	Ok	Ok
S	79.00	645	469	468	790	Ok	Ok
Top	80.00	425	499	498	800	Ok	Ok

Keterangan:
1.Nilai defleksi arah X dan Y didapat dari analisa komputer

Tabel 5.7 Tabel sway desain Alternatif 1

Section	Elevasi (m)	No. Joint	Defleksi Max (mm)	Sway Aktual (degree)	Sway Max (0.5 degree)	Kontrol Sway
1	2	3	4	5	6	7
A	3.00	33	14	0.2674	0.50	Ok
B	9.00	36	35	0.2228	0.50	Ok
C	15.00	37	57	0.2177	0.50	Ok
D	21.00	40	56	0.1528	0.50	Ok
E	27.00	41	67	0.1422	0.50	Ok
F	32.50	44	86	0.1516	0.50	Ok
G	37.50	45	100	0.1528	0.50	Ok
H	42.50	48	70	0.0944	0.50	Ok
I	47.50	219	58	0.0700	0.50	Ok
J	52.00	235	153	0.1686	0.50	Ok
K	56.00	251	193	0.1975	0.50	Ok
L	60.00	266	223	0.2129	0.50	Ok
M	64.00	279	243	0.2175	0.50	Ok
N	68.00	298	323	0.2722	0.50	Ok
O	72.00	190	353	0.2809	0.50	Ok
P	74.00	189	363	0.2811	0.50	Ok
Q	75.00	187	417	0.3186	0.50	Ok
R	77.00	185	433	0.3222	0.50	Ok
S	79.00	184	463	0.3358	0.50	Ok
Top	80.00	182	493	0.3531	0.50	Ok

Keterangan:
1. S = Arc tan (Defleksi/Elevasi)

Tabel 5.8 Tabel sway desain Alternatif 2

Section	Elevasi (m)	No. Joint	Defleksi Max (mm)	Sway Aktual (degree)	Sway Max (0.5 degree)	Kontrol Sway
1	2	3	4	6	6	7
A	3.00	98	10.000	0.1910	0.50	Ok
B	9.00	103	31.000	0.1974	0.50	Ok
C	15.00	105	53.000	0.2024	0.50	Ok
D	21.00	110	52.000	0.1419	0.50	Ok
E	27.00	112	63.000	0.1337	0.50	Ok
F	32.50	115	82.000	0.1446	0.50	Ok
G	37.50	117	96.000	0.1467	0.50	Ok
H	42.50	124	66.000	0.0890	0.50	Ok
I	47.50	314	54.000	0.0651	0.50	Ok
J	52.00	342	149.000	0.1642	0.50	Ok
K	56.00	377	189.000	0.1934	0.50	Ok
L	60.00	405	219.000	0.2091	0.50	Ok
M	64.00	441	239.000	0.2140	0.50	Ok
N	68.00	490	319.000	0.2688	0.50	Ok
O	72.00	463	349.000	0.2777	0.50	Ok
P	74.00	223	359.000	0.2780	0.50	Ok
Q	75.00	232	413.000	0.3155	0.50	Ok
R	77.00	230	429.000	0.3192	0.50	Ok
S	79.00	228	459.000	0.3329	0.50	Ok
Top	80.00	227	489.000	0.3502	0.50	Ok

Keterangan:
1. S = Arc tan (Defleksi/Elevasi)

Tabel 5.9 Tabel sway desain Alternatif 3

Section	Elevasi (m)	No. Joint	Defleksi Max (mm)	Sway Aktual (degree)	Sway Max (0.5 degree)	Kontrol Sway
1	2	3	4	6	6	7
A	3.00	94	20	0.3820	0.50	Ok
B	9.00	95	41	0.2610	0.50	Ok
C	15.00	100	63	0.2406	0.50	Ok
D	21.00	101	62	0.1692	0.50	Ok
E	27.00	104	73	0.1549	0.50	Ok
F	32.50	103	92	0.1622	0.50	Ok
G	37.50	85	106	0.1620	0.50	Ok
H	42.50	111	76	0.1025	0.50	Ok
I	47.50	112	64	0.0772	0.50	Ok
J	52.00	409	159	0.1752	0.50	Ok
K	56.00	405	199	0.2036	0.50	Ok
L	60.00	411	229	0.2187	0.50	Ok
M	64.00	441	249	0.2229	0.50	Ok
N	68.00	211	329	0.2772	0.50	Ok
O	72.00	206	359	0.2857	0.50	Ok
P	74.00	204	369	0.2857	0.50	Ok
Q	75.00	642	423	0.3231	0.50	Ok
R	77.00	644	439	0.3267	0.50	Ok
S	79.00	645	469	0.3401	0.50	Ok
Top	80.00	425	499	0.3574	0.50	Ok

Keterangan:
1. S = Arc tan (Defleksi/Elevasi)

Tabel 5.10 Tabel twist desain Alternatif 1

Section	Elevasi (m)	No. Joint	Twist max (0.5 degree)	Twist Aktual (degree)	Kontrol Twist
1	2	3	6	7	8
A	3.00	98	0.50	0.23	Ok
B	9.00	103	0.50	0.23	Ok
C	15.00	105	0.50	0.25	Ok
D	21.00	110	0.50	0.25	Ok
E	27.00	112	0.50	0.25	Ok
F	32.50	115	0.50	0.27	Ok
G	37.50	117	0.50	0.27	Ok
H	42.50	124	0.50	0.29	Ok
I	47.50	314	0.50	0.31	Ok
J	52.00	342	0.50	0.32	Ok
K	56.00	377	0.50	0.34	Ok
L	60.00	405	0.50	0.34	Ok
M	64.00	441	0.50	0.34	Ok
N	68.00	490	0.50	0.36	Ok
O	72.00	463	0.50	0.37	Ok
P	74.00	223	0.50	0.39	Ok
Q	75.00	232	0.50	0.39	Ok
R	77.00	230	0.50	0.40	Ok
S	79.00	228	0.50	0.42	Ok
Top	80.00	227	0.50	0.43	Ok

Keterangan:

1.Nilai twist dilihat dari analisa komputer

Tabel 5.11 Tabel twist desain Alternatif 2

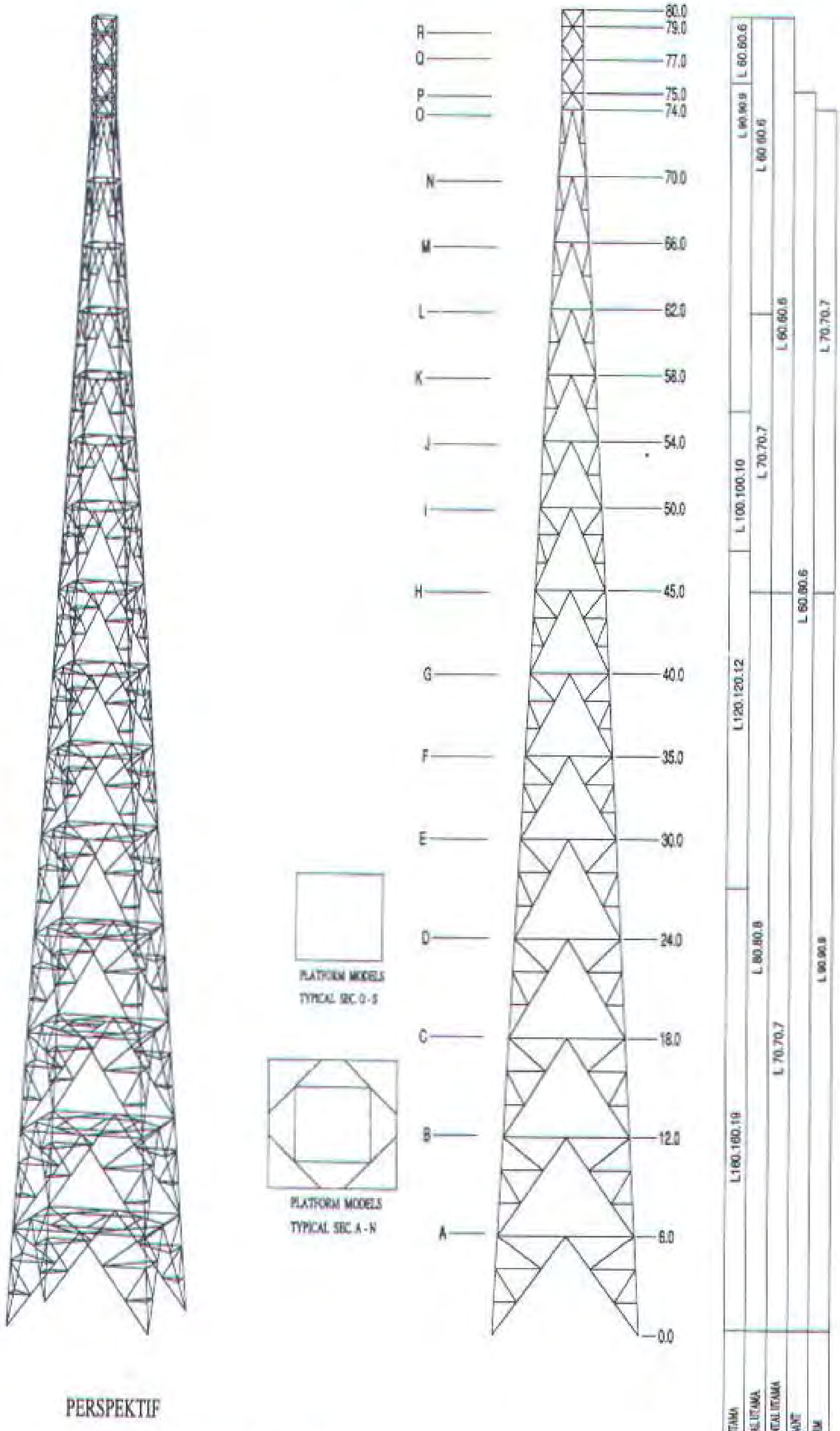
Section	Elevasi (m)	No. Joint	Twist max (0.5 degree)	Twist Aktual (degree)	Kontrol Twist
1	2	3	6	7	8
A	3.00	98	0.50	0.10	Ok
B	9.00	103	0.50	0.10	Ok
C	15.00	105	0.50	0.12	Ok
D	21.00	110	0.50	0.12	Ok
E	27.00	112	0.50	0.12	Ok
F	32.50	115	0.50	0.14	Ok
G	37.50	117	0.50	0.14	Ok
H	42.50	124	0.50	0.16	Ok
I	47.50	314	0.50	0.18	Ok
J	52.00	342	0.50	0.19	Ok
K	56.00	377	0.50	0.21	Ok
L	60.00	405	0.50	0.21	Ok
M	64.00	441	0.50	0.21	Ok
N	68.00	490	0.50	0.23	Ok
O	72.00	463	0.50	0.24	Ok
P	74.00	223	0.50	0.26	Ok
Q	75.00	232	0.50	0.26	Ok
R	77.00	230	0.50	0.27	Ok
S	79.00	228	0.50	0.29	Ok
Top	80.00	227	0.50	0.30	Ok

Keterangan:
1.Nilai twist dilihat dari analisa komputer

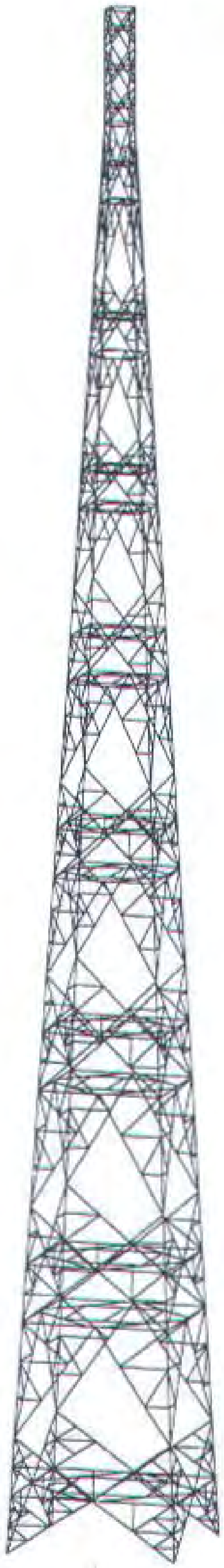
Tabel 5.12 Tabel twist desain Alternatif 3

Section	Elevasi (m)	No. Joint	Twist max (0.5 degree)	Twist Aktual (degree)	Kontrol Twist
1	2	3	6	7	8
A	3.00	94	0.50	0.26	Ok
B	9.00	95	0.50	0.26	Ok
C	15.00	100	0.50	0.28	Ok
D	21.00	101	0.50	0.28	Ok
E	27.00	104	0.50	0.28	Ok
F	32.50	103	0.50	0.30	Ok
G	37.50	85	0.50	0.30	Ok
H	42.50	111	0.50	0.32	Ok
I	47.50	112	0.50	0.34	Ok
J	52.00	409	0.50	0.35	Ok
K	56.00	405	0.50	0.37	Ok
L	60.00	411	0.50	0.37	Ok
M	64.00	441	0.50	0.37	Ok
N	68.00	211	0.50	0.39	Ok
O	72.00	206	0.50	0.40	Ok
P	74.00	204	0.50	0.42	Ok
Q	75.00	642	0.50	0.42	Ok
R	77.00	644	0.50	0.43	Ok
S	79.00	645	0.50	0.45	Ok
Top	80.00	425	0.50	0.46	Ok

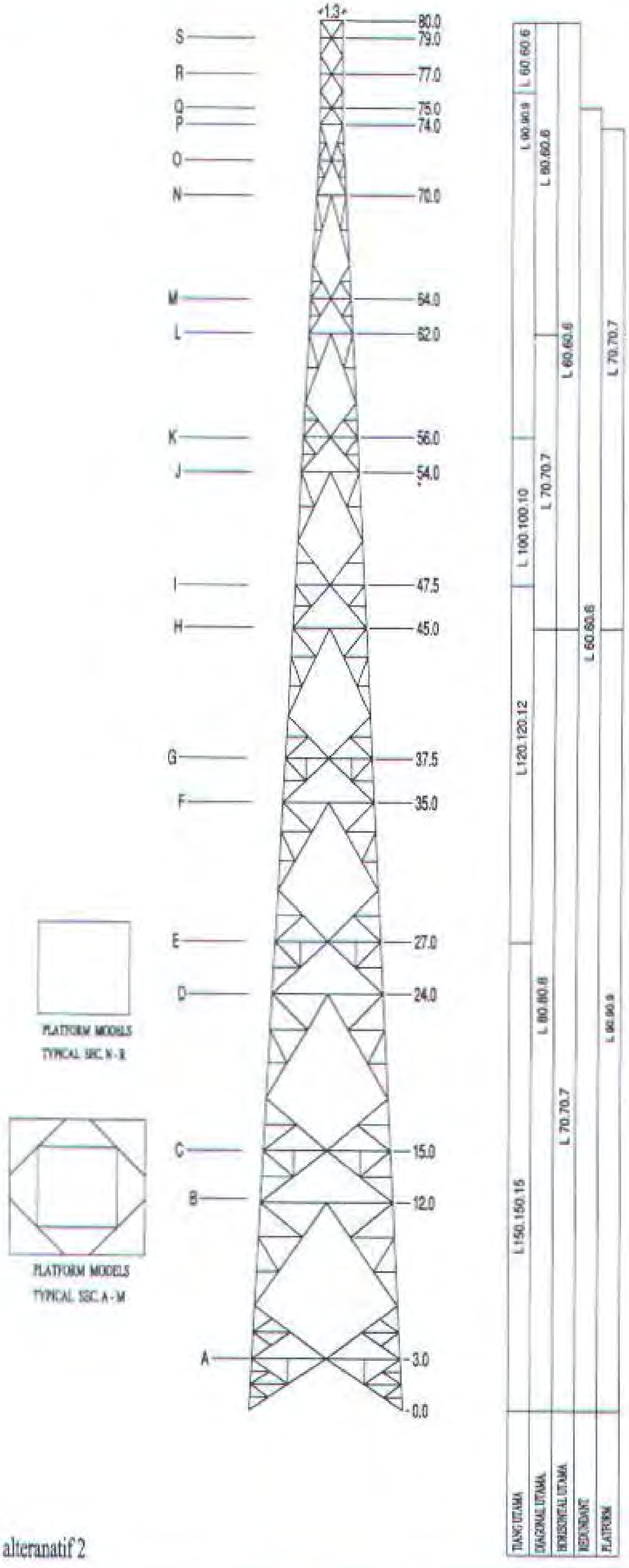
Keterangan:
1.Nilai twist dilihat dari analisa komputer



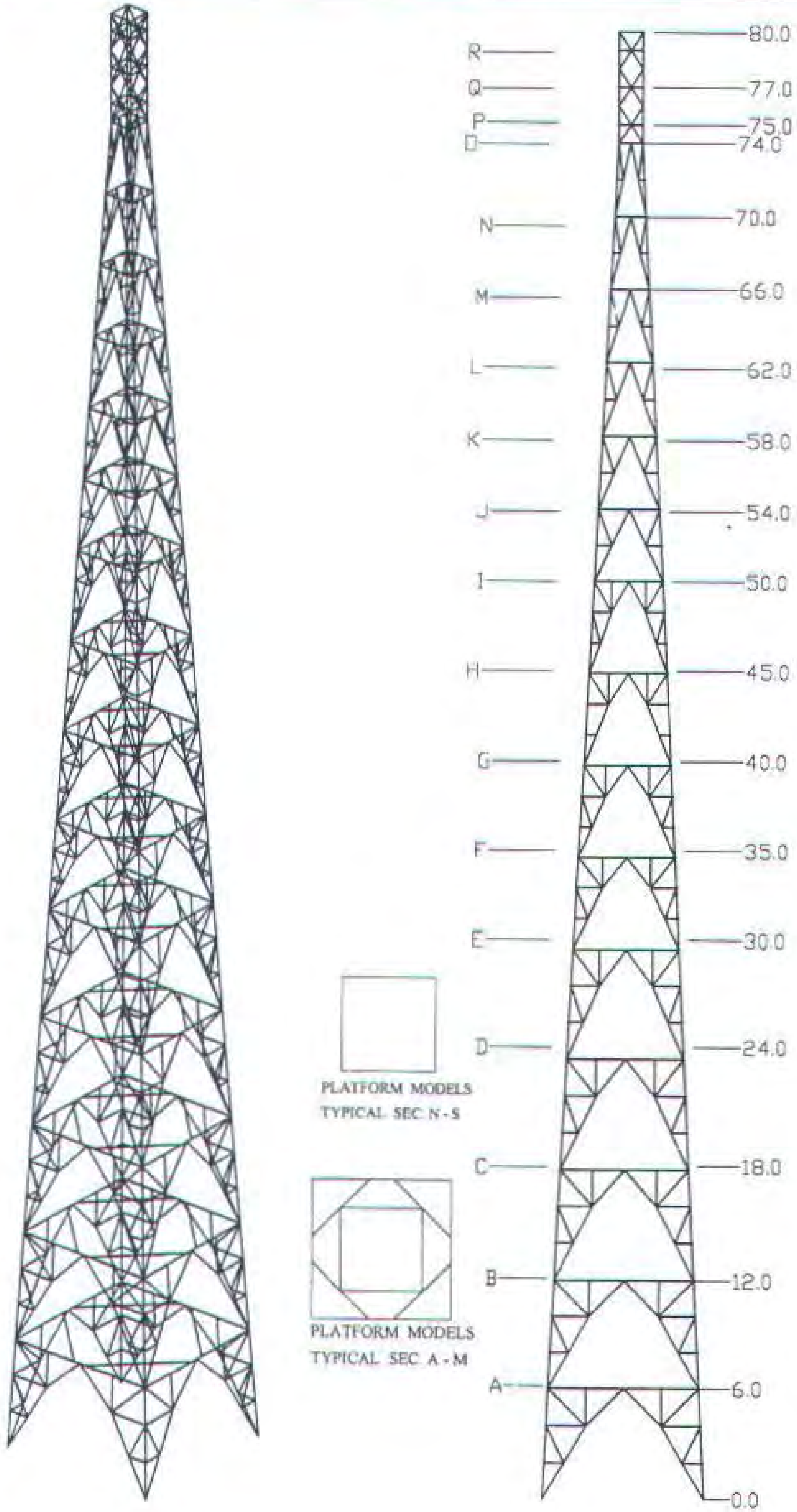
Gambar 5.3 Geometri tower alteranatif 1



PERSPEKTIF



Gambar 5.3 Geometri tower alteranatif 2



PERSPEKTIF

Gambar 5.3 Geometri tower alteranatif 3

BAB VI

PERHITUNGAN STRUKTUR BANGUNAN BAWAH

BAB VI
PERHITUNGAN STRUKTUR BANGUNAN BAWAH

Struktur bangunan bawah merupakan bagian yang sangat vital pada sebuah bangunan. Karena itu perencanaan pondasi harus dilakukan secara cermat dan teliti dengan menggunakan berbagai macam pertimbangan antara lain kondisi tanah, jenis dan struktur tanah serta kemampuan tanah dalam memikul beban yang terjadi pada struktur diatasnya.

Pada perencanaan struktur tower ini, digunakan pondasi tiang pancang untuk lebih dapat menahan beban tekan maupun tarik akibat beban – beban lateral tower.

6.1. Data Perencanaan

Kedalaman tiang pancang	: 7 m
Dimensi tiang pancang	: 20 x 20 cm^2 (Ex.JHS Pile)
Keliling tiang pancang (K)	: 80 cm
Luas tiang pancang (A)	: 400 cm^2
Nilai conus (C) rata- rata	: 200 kg/cm^2
Nilai JHP	: 350 kg/cm
Mutu beton (fc')	: 25 Mpa
Mutu baja (fy)	: 400 Mpa

6.2. Perencanaan Tiang Pancang

Dimensi Pile Cap : B = 2m
L = 2m
t = 0,5m
Volume = 2 m^3
Berat = 4800 kg

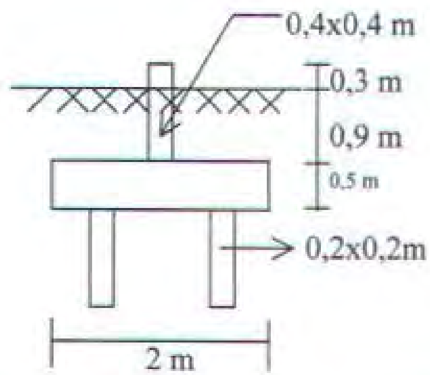
Dimensi kolom pedestal : b = 0,4 m

h = 0,4 m

L= 1,2 m

Volume = 0,192 m^3

Berat = 460,8 kg



gambar 6.1. tampak samping pondasi

Berat dari pile cap dan kolom = 5260,8 kg

Berat dari tanah diatas pondasi :

γt = 1720 kg/m^3

Berat = ((2x2x0,9) – (0,4x0,4x0,9))x1720

= 9728 kg

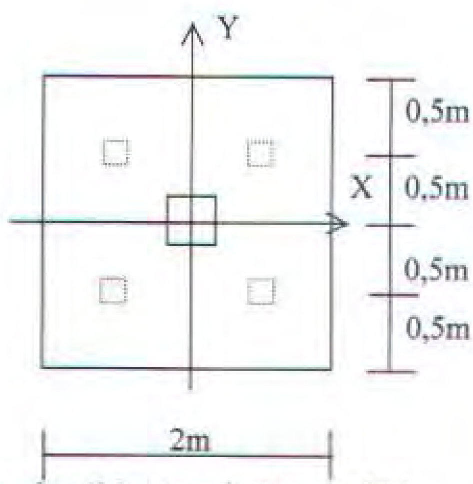
Daya dukung tanah :

$$Qall = \frac{AxCn}{3} + \frac{KxJHP}{5}$$

$$Qall = \frac{400x200}{3} + \frac{80x350}{5}$$

Qall =27387 kg

$$\text{Effisiensi } (\eta) = 1-\theta\frac{(n-1)m+(m-1)n}{90mn}$$



gambar 6.1. tampak atas pondasi

θ = arc tg D/S

= arc tg 20/100

= 11,31

$$\text{Effisiensi } (\eta) = 1-\theta\frac{(n-1)m+(m-1)n}{90mn}$$

$$\text{Effisiensi } (\eta) = 1-11{,}31\frac{(2-1)2+(2-1)2}{90x2x2}$$

$(\eta) = 0,88$

Jadi daya dukung tiap tiang :

Q ijin 1 tiang = ηxqu

= 0,88x27387 = 24497 kg

Kekuatan 1 (satu) tiang diperoleh dari table spesifikasi fabrikasi dari JHS Pile yaitu sebagai berikut;

Pu = 59160 kg

Mu = 3060 kgm

Dari kekuatan bahan terseut diperoleh kekuatan tanah lebih kecil dari kekuatan tiang itu sendiri, sehingga harga kekuatan tanah tersebut lebih menentukan untuk dijadikan dasar perhitungan kekuatan tiang pancang (Pall tiang pancang = 24497 kg)

Gaya-gaya yang terjadi hasil analisa struktur :

P = 12622 kg (tekan)

P = -1410 kg (tarik)

H_x = 6979 kg

H_y = 7066 kg

Gaya-gaya total yang terjadi :

Gaya aksial tekan (P) = 12622 + 5260,8+5633,28 = 23516 kg

Gaya aksial tarik (P) = -1410 + 5260,8 + 5633,28 = 9485kg

Momen arah x (M_x) = 6979 x 1,7 = 11865 kgm

Momen arah y (M_y) = 7066 x 1,7 = 12012 kgm

Perhitungan Pmax :

$$\text{Pmax} = \frac{P}{n} \pm \frac{M_x Y}{\sum Y^2} \pm \frac{M_y X}{\sum X^2} \qquad \sum X^2 = 2x2x0.5^2 = 1m^2$$

Akibat P tekan : $\sum Y^2 = 2x2x0.5^2 = 1m^2$

$$\text{Pmax} = \frac{23516}{4} + \frac{11865x0,5}{1} + \frac{12012x0,5}{1} = 17818 \text{ kg}$$

$$\text{Pmax} = \frac{23516}{4} - \frac{11865x0,5}{1} - \frac{12012x0,5}{1} = -6060 \text{ kg}$$

$$\text{Pmax} = \frac{23516}{4} + \frac{11865x0,5}{1} - \frac{12012x0,5}{1} = 5806 \text{ kg}$$

$$\text{Pmax} = \frac{23516}{4} - \frac{11865x0,5}{1} + \frac{12012x0,5}{1} = 5953 \text{ kg}$$

Pmax = 17818 kg

Pmin = - 6060 kg

P max = 17818 kg < Q ijin 1 tiang = 24497 kg.........................(Ok).

6.3. Kontrol Tiang Terhadap Gaya Lateral (Horisontal)

Untuk menentukan daya dukung horisontal yang diijinkan dapat ditentukan dengan persamaan sebagai berikut :

$$Ha = \frac{KxD}{\beta}\delta a$$ (Teknik Pondasi Ir.Suyono S. Hal. 106)

Dimana :

Ha = daya dukung horisontal yang diijinkan (kg)

K = koefisien reaksi lapisan tanah di bawah permukaan tanah dalam arah vertikal (kg/cm^2)

D = diameter tiang (cm)

δa = besar pergeseran normal (cm)

$$\beta = \sqrt[4]{\frac{KXD}{4EI}}$$

Perkiraan koefisien (K) dari reaksi tanah dibawah permukaan dalam arah mendatar adalah sebagai berikut :

$K = Koxy^{-1/2}$

$Ko = 0{,}2xEoxD^{-3/4}$

Ko = harga K bila pergeseran permukaan sebesar 1 cm (kg/cm^3)

y = besarnya pergeseran (cm)

Eo = modulus deformasi tanah (Eo = 28 N)

D = dameter tiang (cm)

N = nilai conus rata – rata 4D atas 4D bawah

$N_{rata-rata} = 370 kg/cm^2$ (kedalaman 7 m)

$Eo = 28\ N = 28 \times 337 = 10360 kg/cm^2$

$$\begin{aligned} Ko &= 0{,}2 \times Eo \times D^{-3/4} \\ &= 0{,}2 \times 10360 \times 20^{-3/4} \\ &= 219 \end{aligned}$$

$K = Koxy^{-1/2} = 219x1^{-1/2} = 219$

Momen inersia tiang :

$$I = \frac{1}{12}D^4 = \frac{1}{12}20^4 = 13333{,}33 cm^4$$

$$\beta = \sqrt[4]{\frac{KXD}{4EI}} = \sqrt[4]{\frac{219x20}{4x2{,}1x10^5x13333{,}33}} = 0{,}19$$

$$Ha = \frac{KxD}{\beta}\delta a = \frac{219x20}{0,19}x1 = 23053kg \quad > H = 7066 \text{ kg} \quad (\text{Ok !})$$

6.4. Perencanaan Pile Cap (Poer)

Data perencanaan :

b = 2000 mm

h = 500 mm

d = 425 mm

fc' = 25 Mpa

fy = 400 Mpa

6.4.1. Penulangan Lentur

Kontrol balok tinggi :

$$\frac{Ln}{d} = \frac{1000}{425} = 2,35 \leq 5 \Rightarrow \text{Balok tinggi (SKSNI Ps.3.4.8-1)}$$

P tiang = Pmax + (berat pedestal + berat poer + berat tanah)/4

$$\text{P tiang} = 23516 + \frac{460,8 + 4800 + 9728}{4} = 27263kg$$

2P tiang = 54526 kg

Mmax = 2P x 500

Mmax = 54526 x 500

Mmax = 27263200kgmm

Mmax = 272632000 Nmm

Mu = 1,2 x 272632000 = 545262000 Nmm

Mn = Mu/0,8 = 545262000/0,8=681577500 Nmm

$$Rn = \frac{Mn}{bd^2} = \frac{681577500}{2000x425^2} = 0,44$$

$$m = \frac{Fy}{0{,}85xFc'} = 18{,}82$$

$$\rho \text{ min} = \frac{1{,}4}{Fy} = 0{,}0035$$

$$\rho \text{ perlu} = \frac{1}{m}x\left(1-\sqrt{1-\frac{2xmxRn}{Fy}}\right)$$

$$\rho \text{ perlu} = \frac{1}{18{,}82}x\left(1-\sqrt{1-\frac{2x18{,}82x0{,}44}{400}}\right) = 0{,}0021$$

As = ρ x b x d = 0,0035 x 2000 x 425 = 2975 mm^2

Dipakai tulangan D20 (As=283,39 mm^2)

Dipasang tulangan D20 -150 (As = 3684 mm^2)

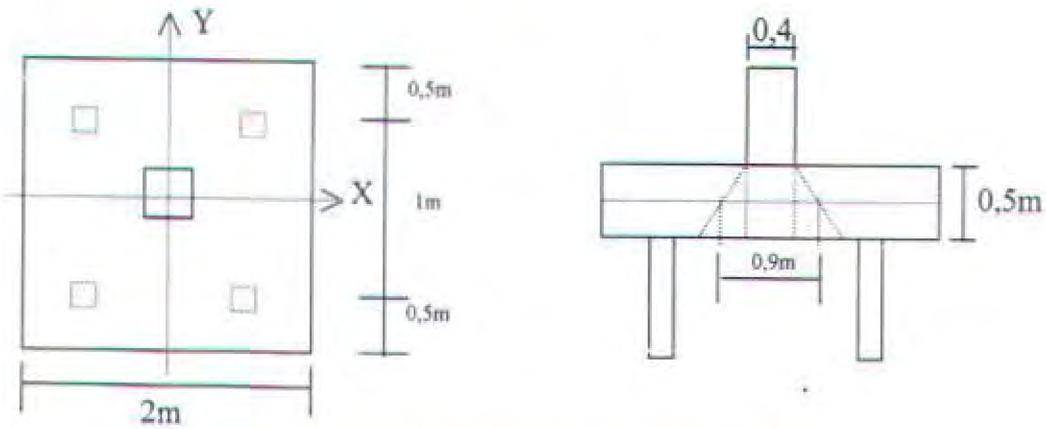
6.4.2. Perhitungan Tulangan Geser

Vu = 1,2 x 2P = 1,2 x 27263 kg = 32716 kg

$$\phi Vc = 0{,}6 \text{ x } \frac{1}{6}x\sqrt{fc'}xbxd$$

$$\phi Vc = 0{,}6 \text{ x } \frac{1}{6}x\sqrt{25}x2000x425 = 708333N \Rightarrow Vu < \phi Vc \text{.... (tidak perlu tul geser)}$$

6.4.3. Kontrol Geser Pons Akibat Kolom Pedestal



gambar 6.3. daerah geser pons akibat kolom pedestal

Bo = keliling daerah kritis = ((0,25x2) + 0,4)x4 =3600mm

$$\beta c = \frac{0,4}{0,4} = 1$$

$$Vc = \left(1 + \frac{2}{\beta c}\right) x \frac{1}{6} \sqrt{fc'} xBoxd$$

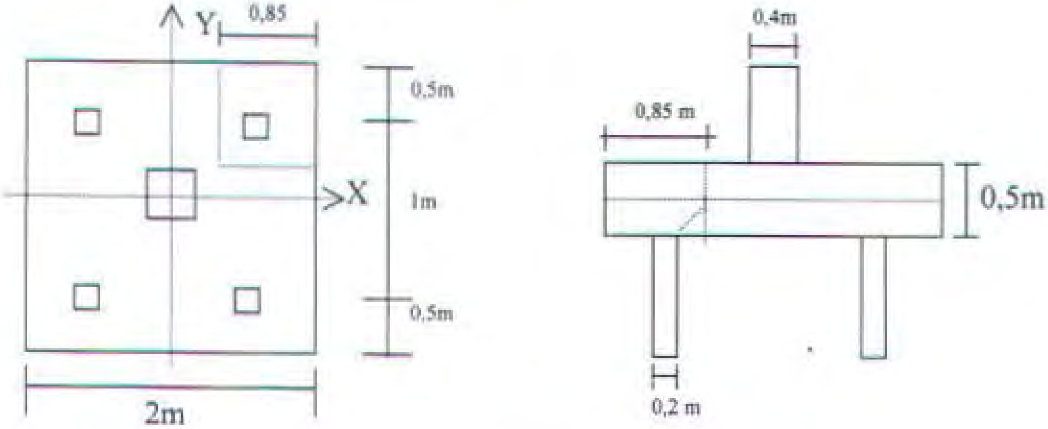
$$Vc = \left(1 + \frac{2}{1}\right) x \frac{1}{6} \sqrt{25} x3600x425 = 3825000\,N$$

$$Vc = \frac{\sqrt{Fc'}}{3} xBoxdx\beta c$$

$$Vc = \frac{\sqrt{25}}{3} x3600x425x1 = 2550000N$$ ....(menentukan)

$$Vn = \frac{Pu}{\theta} = \frac{13177}{0,6} = 186133N < Vc$$ (Tidak perlu tulangan Pons)

6.4.4. Kontrol Geser Pons Akibat Tiang Pancang



gambar 6.4. daerah geser pons akibat tiang pancang

Bo = keliling daerah kritis tinjauan 1 tiang = 850 x 2 = 1700 mm

$$\beta c = \frac{0,2}{0,2} = 1$$

$$Vc = \left(1 + \frac{2}{\beta c}\right) x \frac{1}{6} \sqrt{fc'} xBoxd$$

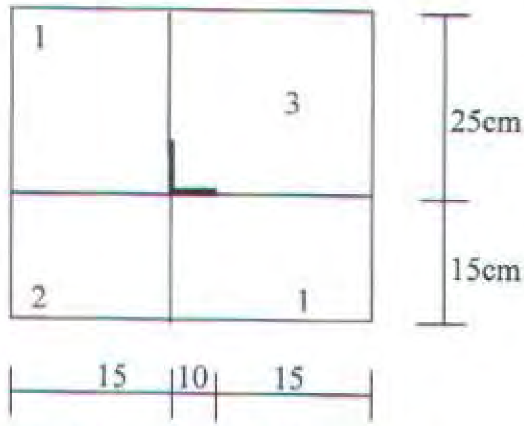
$$Vc = \left(1 + \frac{2}{1}\right) x \frac{1}{6} \sqrt{25} x1700x425 = 1806250\,N$$

$$Vc = \frac{\sqrt{Fc'}}{3} xBoxdx\beta c$$

$$Vc = \frac{\sqrt{25}}{3} x1700x425x1 = 1204167N$$ ....(menentukan)

$$Vn = \frac{Pu}{\theta} = \frac{235160}{0,6} = 391930N < Vc$$ (Tidak perlu tulangan Pons)

6.5. Perhitungan Base Plate



gambar 6.5. tampak atas base plate

Gaya-gaya yang terjadi di base plate:

P = 12622kg (tekan)
P = -1410 kg (tarik)
Hx = 6979 kg
Hy = 7066 kg

B = 40cm
L = 40cm
A = 1600 cm^2

W = 1/6 x Bx L^2 = 1/6x40x40^2=10667 cm^3

σbt = 250 kg/cm^2

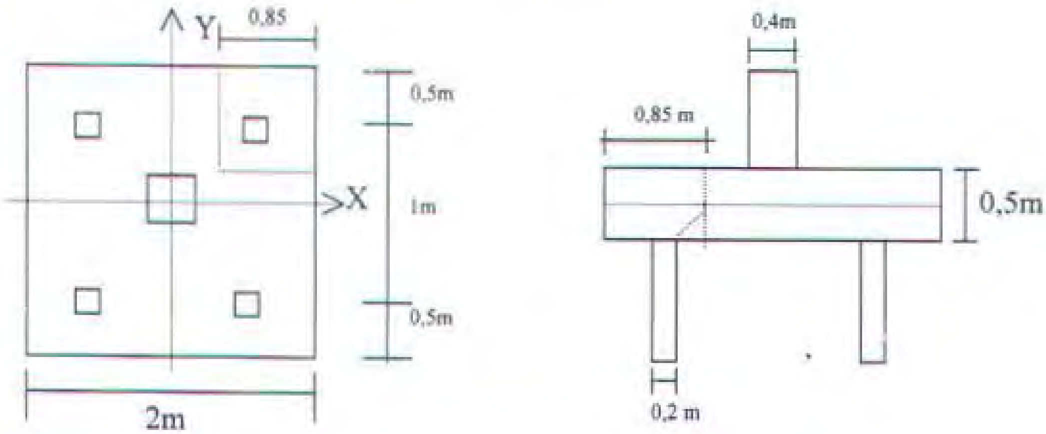
Tegangan yang terjadi untuk P tekan :

$$\sigma = \frac{P}{A} = \frac{12622}{1600}$$

σ max = 8,24 kg/cm^2 < σbt = 250 kg/cm^2
Tegangan yang terjadi untuk P tarik :

$$\sigma = \frac{P}{A} = \frac{-1410}{1600}$$

6.4.4. Kontrol Geser Pons Akibat Tiang Pancang



gambar 6.4. daerah geser pons akibat tiang pancang

Bo = keliling daerah kritis tinjauan 1 tiang = 850 x 2 = 1700 mm

$$\beta c = \frac{0,2}{0,2} = 1$$

$$Vc = \left(1 + \frac{2}{\beta c}\right) x \frac{1}{6} \sqrt{fc'} xBoxd$$

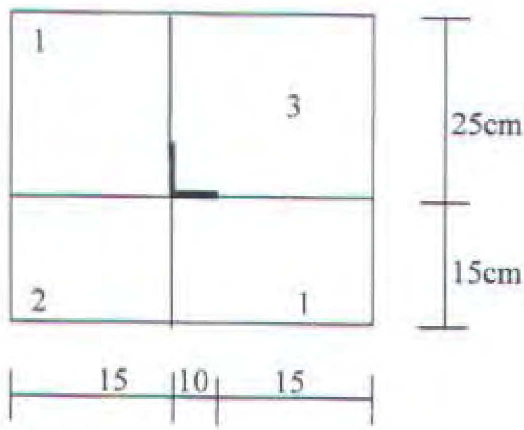
$$Vc = \left(1 + \frac{2}{1}\right) x \frac{1}{6} \sqrt{25} x1700x425 = 1806250\,N$$

$$Vc = \frac{\sqrt{Fc'}}{3} xBoxdx\beta c$$

$$Vc = \frac{\sqrt{25}}{3} x1700x425x1 = 1204167N$$ ....(menentukan)

$$Vn = \frac{Pu}{\theta} = \frac{235160}{0,6} = 391930N < Vc$$ (Tidak perlu tulangan Pons)

6.5. Perhitungan Base Plate



gambar 6.5. tampak atas base plate

Gaya-gaya yang terjadi di base plate:

P = 12622kg (tekan)
P = -1410 kg (tarik)
Hx = 6979 kg
Hy = 7066 kg

B = 40cm
L = 40cm
A = 1600 cm^2

$W = 1/6 \times Bx\ L^2 = 1/6x40x40^2 = 10667\ cm^3$

$\sigma bt = 250\ kg/cm^2$

Tegangan yang terjadi untuk P tekan :

$$\sigma = \frac{P}{A} = \frac{12622}{1600}$$

$\sigma\ max = 8{,}24\ kg/cm^2 < \sigma bt = 250\ kg/cm^2$
Tegangan yang terjadi untuk P tarik :

$$\sigma = \frac{P}{A} = \frac{-1410}{1600}$$

σ max = - 4,94 kg/cm^2 < σbt = 250 kg/cm^2

Beban terbagi rata pelat q = 8,24 kg/cm^2

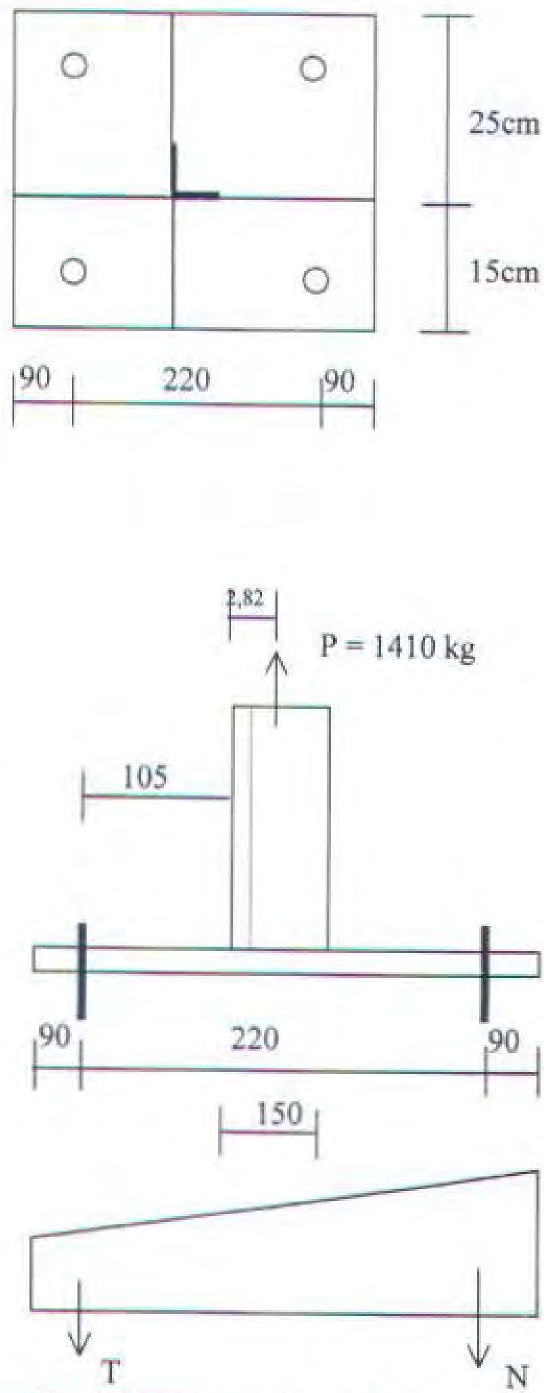
Momen maksimum pelat terletak di daerah 3 dapat dianalisa dengan SAP :

M = 425 kg cm Mu = 510 kg cm

Tebal base plate = $\sqrt{\dfrac{4xMu}{\phi Fy}} = \sqrt{\dfrac{4x510}{0,9x2400}} = 0,97 \approx 1,6cm$

Dipasang tebal base plate 1,6 cm

6.6. Perhitungan baut angker



gambar 6.6. posisi angker pada base plate

$-1410 \times 107{,}82 + N \times 220 = 0$

$$N = \frac{852964}{220} = 3877kg \qquad Nu = 1,2x\ 3877 = 4652,4\ kg$$

$$\text{Luas baut Angker} = \frac{Nu}{\phi 0,75Fu} = \frac{4652,4}{0,75x0,75x3700} = 2,23cm^2$$

Dipasang 2 baut angker D 12mm (A=2,26 cm^2) tiap sisi .

Perhitungan panjang angker yang dibutuhkan :

Fct x Aselimut x h > N

Fct = kuat tarik ijin beton

$$Fct = 0,5\sqrt{Fc'} = 25\frac{kg}{cm^2}$$

$$H = \frac{3877}{25x3,14x1,2} = 41,15cm$$

dipasang baut angker ϕ12 mm panjang 45 cm

6.7 Perhitungan Balok Sloof

Beban-beban yang diterima oleh sloof antara lain berat sendiri sloof, berat tanah, dan berat beban aksial yang berasal dari beban aksial kolom sebesar 10%,sehingga balok sloof direncanakan seperti merencanakan kolom. (PPSBBSTBUG'83-6.9.2)

Direncanakan balok sloof : b = 200 mm
h = 300 mm

Berat pada balok sloof :

- berat sendiri sloof : 0,2 x 0,3 x 2400 = 144 kg/m
- berat tanah : 0,2 x 0,9 x 1630 = 2903,4 kg/m

= 437,4 kg/m

Perhitungan momen sloof :

$$M = \frac{1}{12} xqxl^2$$

$$= \frac{1}{12} x437,4x3,26^2 = 387,37 kgm = 3873700 Nmm$$

Mu = 1,2 x 3873700 = 4648440 Nmm

P = 126220+ 4608 = 136378 N

P = 136378 x 10% N = 13637,8 N

Pu = 1,2 x 13637,8 = 16365 N

$$e = \frac{Mu}{Pu} = \frac{4648440}{16365} = 284$$

$$\frac{e}{h} = \frac{284}{300} = 0,94$$

Dari diagram interaksi M-N didapatkan :

$$\text{Sumbu horisontal} = \frac{Pu}{\phi.Agr.0,85.fc'} x \left(\frac{e}{h}\right) = \frac{16365}{0,65x200x300x0,85x25} x0,94 = 0,018$$

$$\text{Sumbu horisontal} = \frac{Pu}{\phi.Agr.0,85.fc'} = \frac{16365}{0,65x200x300x0,85x25} = 0,019$$

r = 0,01

$\beta = 1$

$\rho = r \times \beta = 0,01$

As = ρ x Agr = 0,01 x 200 x300 = 600 mm^2

Dipasang 4D16 (As = 803,84 mm^2)

Perhitungan tulangan geser sloof

V = ½ x q x l = ½ x 437,4 x 3,26 = 712,96 kg = 7129,6 N

Vu = 1,2 x 7129,6 = 8555,52 N

$$\phi Vc = 0,6x\frac{1}{6}x\sqrt{fc'}xbxd = 0,6x\frac{1}{6}x\sqrt{25}x200x255 = 25500N$$

Vu < ϕVc (tidak perlu tulangan geser)

Dipasang tulangan geser praktis D10 –10

6.9. Perhitungan Tulangan Pedestal

Dimensi kolom : b = 400 mm
h = 400 mm

P = 126220 N

Pu = 1,2 x 126220 = 163654 N

H = 10670 x panjang pedestal

M = 10670 N x 1,2 m = 12804Nm

Mu = 12804 x 1,2 = 15364,8 Nm

Mu = 15364800 Nmm

$$e = \frac{Mu}{P} = \frac{15364800}{163654} = 148,23$$

$$\frac{e}{h} = \frac{148,23}{400} = 0,37$$

Dari diagram interaksi M-N didapatkan :

$$\text{Sumbu horisontal} = \frac{Pu}{\phi.Agr.0,85.fc'} x \left(\frac{e}{h}\right) = \frac{163654}{0,65x400x400x0,85x25} x0,37 = 0,02$$

$$\text{Sumbu horisontal} = \frac{Pu}{\phi.Agr.0,85.fc'} = \frac{163654}{0,65x400x400x0,85x25} = 0,07$$

r = 0,01

$\beta = 1$

$\rho = r \times \beta = 0,01$

As = ρ x Agr = 0,01 x 400 x 400 = 1600 mm^2

Dipakai tulangan D19 (As = 283,38)

Dipasang 8D19 (As = 2267,04 mm^2)

Perhitungan tulangan geser pedestal

V = 706660 N

$Vu = 1,2 \times 70660 \text{ N} = 84792\text{N}$

$\phi Vc = 0,6x\frac{1}{6}x\sqrt{fc'}xbxd = 0,6x\frac{1}{6}x\sqrt{25}x400x340 = 408000\text{N}$

$Vu < \phi Vc$ (tidak perlu tulangan geser)

Dipasang tulangan geser praktis D10 –150

BAB VII
KESIMPULAN

BAB VII
KESIMPULAN

Tugas Akhir yang berjudul "Modifikasi struktur tower baja 80 m pada proyek pembangunan RBS CDMA PT. Mobile 8 Telecom dengan 3 (tiga) alternatif" ini, merupakan suatu studi perencanaan struktur khususnya konstruksi baja untuk merencanakan suatu struktur yang kuat, aman, ekonomis, dan efisien. Dari berbagai macam modifikasi desain yang direncanakan, berat aktualnya adalah

a. Desain semula mempunyai berat sendiri 32920 kg
b. Desain alternatif 1 mempunyai berat sendiri 27196 kg
c. Desain alternatif 2 mempunyai berat sendiri 25310 kg
d. Desain alternatif 3 mempunyai berat sendiri 28755 kg

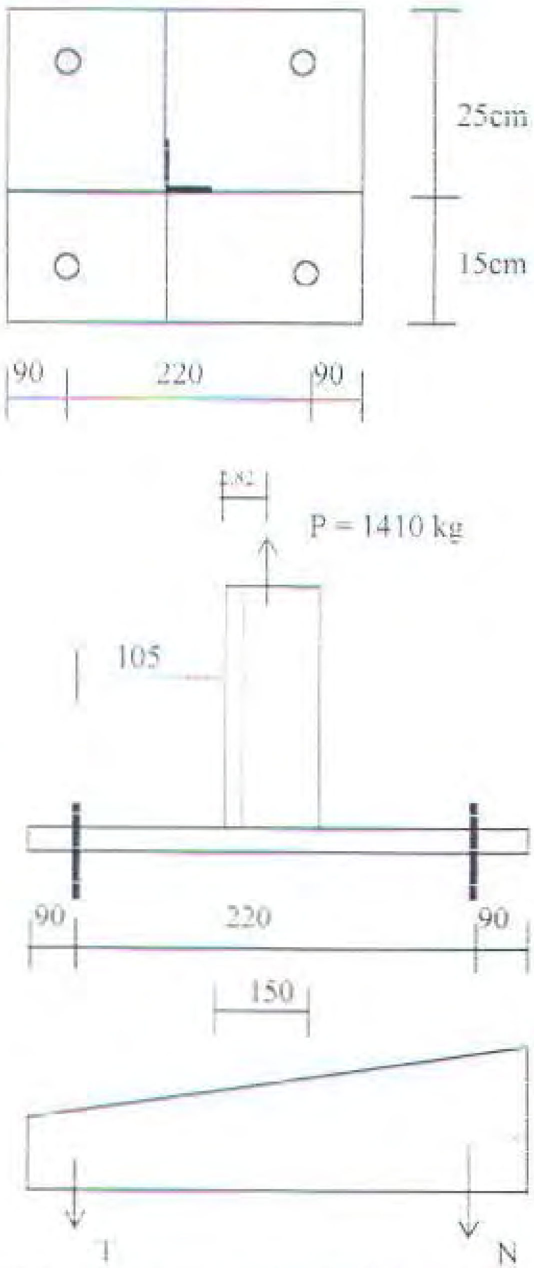
Alternatif 2 mempunyai berat yang paling ringan, sehingga dapat dikatakan desain yang paling ekonomis ditinjau dari segi bahan. Desain pada modifikasi struktur tower baja ini masih bisa di buat lebih eknomis lagi dengan cara mengubah panjang tiap segmen dari desain semula.

LAMPIRAN

ADDENDUM

Addendum merupakan tambahan dan revisi pada tugas akhir ini yang dipergunakan untuk melengkapi dan menyempurnakan laporan.

.1. Perhitungan baut angker



gambar 6.6. posisi angker pada base plate

(-1410 x 107,82) + (N x 220)= 0

N = 152027/220 = 691 kg
Nu = 1,2x 691 = 829 kg

Luas baut Angker = Nu/(0,75x0,75x Fu) = 829/(0,75x0,75x3700) = 1,96 cm^2

Dipasang 2 baut angker D 12mm (A=2,26 cm^2) tiap sisi .

Perhitungan panjang angker yang dibutuhkan :

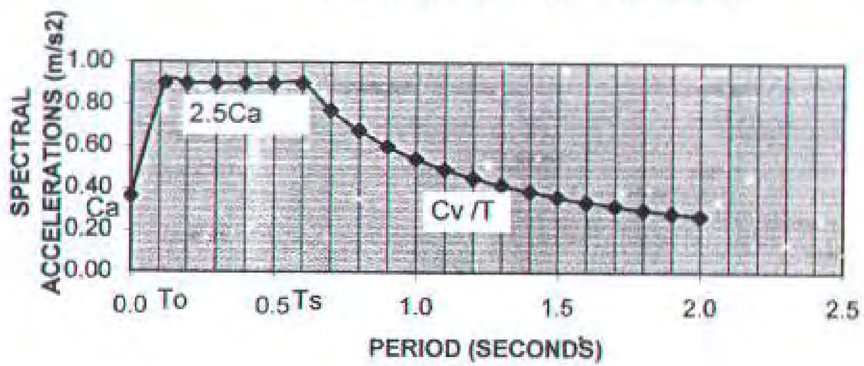
Fct x Aselimut x H > N

Fct = kuat lekat ijin beton
$Fct = 0{,}5\sqrt{Fc'} = 25\frac{kg}{cm^2}$

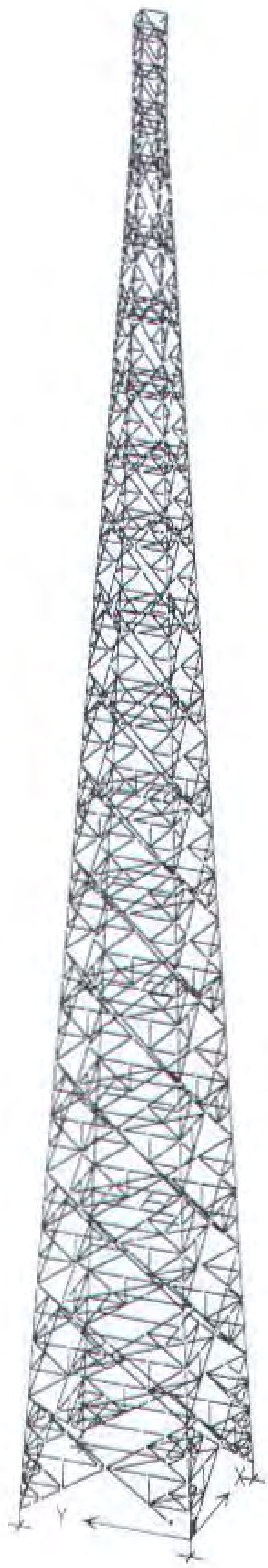
H = 829/(25x3.14x12) = 12 cm
dipasang baut angker ϕ12 mm panjang 45 cm

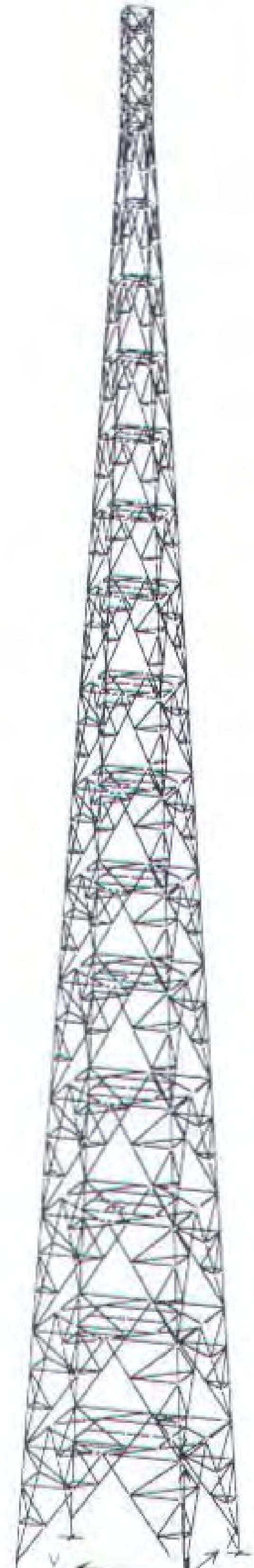
Cv = 0.54 (tabel 16-R UBC 1997)
Ca = 0.36 (tabel 16-Q UBC 1997)
Ts = Cv/2.5Ca = 0.6 sec
To = 0.2 Ts = 0.12 sec

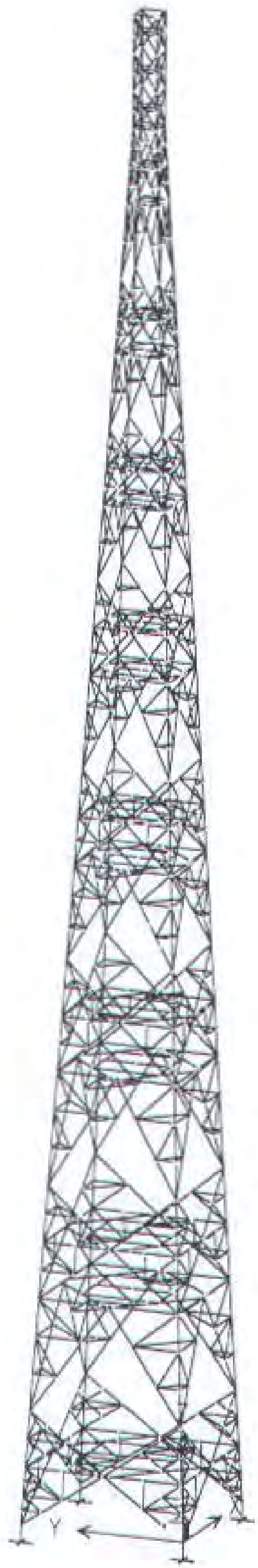
Periode (sec)	Spectral acceleration (m/sec2)
0.00	0.360
0.12	0.900
0.20	0.900
0.30	0.900
0.40	0.900
0.50	0.900
0.60	0.900
0.70	0.771
0.80	0.675
0.90	0.600
1.00	0.540
1.10	0.491
1.20	0.450
1.30	0.415
1.40	0.386
1.50	0.360
1.60	0.338
1.70	0.318
1.80	0.300
1.90	0.284
2.00	0.270

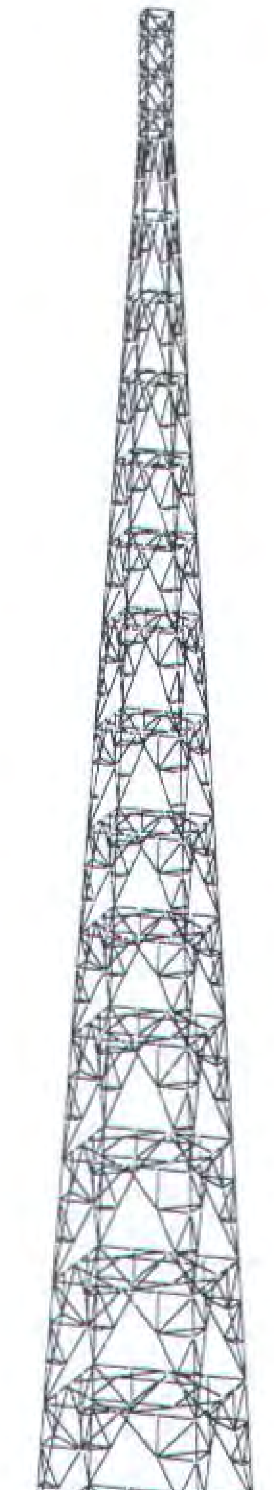


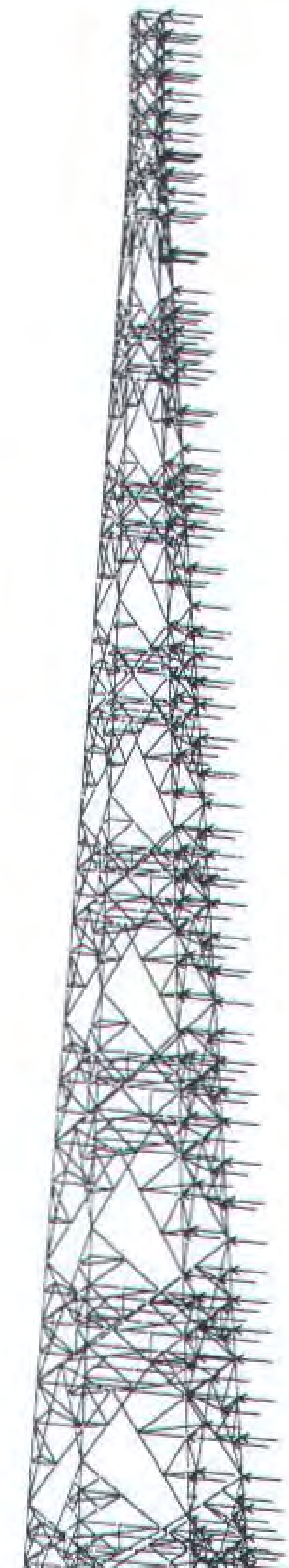
Tabel 4.10 Desain response spektrum


Y
X




Y


Y


Y

eda

TIC LOAD CASES

STATIC CASE	CASE TYPE	SELF WT FACTOR
BS	DEAD	1.0000
MATI	DEAD	0.0000
HIDUP	LIVE	0.0000
WIND0	WIND	0.0000
WIND45	WIND	0.0000
FA0	WIND	0.0000
FS0	WIND	0.0000
FA45	WIND	0.0000
FS45	WIND	0.0000
ANTENA	DEAD	0.0000
GEMPA	QUAKE	0.0000

eda

NT DATA

NT	GLOBAL-X	GLOBAL-Y	GLOBAL-Z	RESTRAINTS	ANGLE-A	ANGLE-B	ANGLE-C
1	8.91300	0.00000	0.00000	1 1 1 1 1 1	0.000	0.000	0.000
2	8.87442	0.03858	0.75000	0 0 0 0 0 0	0.000	0.000	0.000
3	8.83584	0.07716	1.50000	0 0 0 0 0 0	0.000	0.000	0.000
4	8.79726	0.11574	2.25000	0 0 0 0 0 0	0.000	0.000	0.000
5	8.75868	0.15432	3.00000	0 0 0 0 0 0	0.000	0.000	0.000
6	8.68152	0.23148	4.50000	0 0 0 0 0 0	0.000	0.000	0.000
7	8.60436	0.30864	6.00000	0 0 0 0 0 0	0.000	0.000	0.000
8	8.50149	0.41151	8.00000	0 0 0 0 0 0	0.000	0.000	0.000
9	8.39861	0.51439	10.00000	0 0 0 0 0 0	0.000	0.000	0.000
10	8.29573	0.61727	12.00000	0 0 0 0 0 0	0.000	0.000	0.000
11	8.21857	0.69443	13.50000	0 0 0 0 0 0	0.000	0.000	0.000
12	8.14141	0.77159	15.00000	0 0 0 0 0 0	0.000	0.000	0.000
13	8.06425	0.84875	16.50000	0 0 0 0 0 0	0.000	0.000	0.000
14	7.98709	0.92591	18.00000	0 0 0 0 0 0	0.000	0.000	0.000
15	7.88422	1.02878	20.00000	0 0 0 0 0 0	0.000	0.000	0.000
16	7.78134	1.13166	22.00000	0 0 0 0 0 0	0.000	0.000	0.000
17	7.67846	1.23454	24.00000	0 0 0 0 0 0	0.000	0.000	0.000
18	7.60130	1.31170	25.50000	0 0 0 0 0 0	0.000	0.000	0.000
19	7.52414	1.38886	27.00000	0 0 0 0 0 0	0.000	0.000	0.000
20	7.44698	1.46602	28.50000	0 0 0 0 0 0	0.000	0.000	0.000
21	7.36982	1.54318	30.00000	0 0 0 0 0 0	0.000	0.000	0.000
22	7.28413	1.62887	31.66600	0 0 0 0 0 0	0.000	0.000	0.000
23	7.19838	1.71462	33.33300	0 0 0 0 0 0	0.000	0.000	0.000
24	7.11263	1.80037	35.00000	0 0 0 0 0 0	0.000	0.000	0.000
25	7.04833	1.86467	36.25000	0 0 0 0 0 0	0.000	0.000	0.000
26	6.98403	1.92897	37.50000	0 0 0 0 0 0	0.000	0.000	0.000
27	6.91973	1.99327	38.75000	0 0 0 0 0 0	0.000	0.000	0.000
28	6.85543	2.05757	40.00000	0 0 0 0 0 0	0.000	0.000	0.000
29	6.76973	2.14327	41.66600	0 0 0 0 0 0	0.000	0.000	0.000
30	6.68399	2.22901	43.33300	0 0 0 0 0 0	0.000	0.000	0.000
31	6.59824	2.31476	45.00000	0 0 0 0 0 0	0.000	0.000	0.000
32	8.91300	8.91300	0.00000	1 1 1 1 1 1	0.000	0.000	0.000
33	8.87442	8.87159	0.75000	0 0 0 0 0 0	0.000	0.000	0.000
34	8.83584	8.83584	1.50000	0 0 0 0 0 0	0.000	0.000	0.000
35	8.79726	8.80009	2.25000	0 0 0 0 0 0	0.000	0.000	0.000
36	8.75868	8.75868	3.00000	0 0 0 0 0 0	0.000	0.000	0.000
37	8.68152	8.68152	4.50000	0 0 0 0 0 0	0.000	0.000	0.000
38	8.60436	8.60436	6.00000	0 0 0 0 0 0	0.000	0.000	0.000
39	8.50149	8.50149	8.00000	0 0 0 0 0 0	0.000	0.000	0.000
0	8.39861	8.39861	10.00000	0 0 0 0 0 0	0.000	0.000	0.000
1	8.29573	8.29573	12.00000	0 0 0 0 0 0	0.000	0.000	0.000
2	8.21857	8.21857	13.50000	0 0 0 0 0 0	0.000	0.000	0.000
3	8.14141	8.14141	15.00000	0 0 0 0 0 0	0.000	0.000	0.000
4	8.06425	8.06425	16.50000	0 0 0 0 0 0	0.000	0.000	0.000
5	7.98709	7.98709	18.00000	0 0 0 0 0 0	0.000	0.000	0.000
6	7.88422	7.88422	20.00000	0 0 0 0 0 0	0.000	0.000	0.000
7	7.78134	7.78134	22.00000	0 0 0 0 0 0	0.000	0.000	0.000

00 v7.42 File: TOWER ALT.20KE Kgf-m Units PAGE 1
4 1:36:52

eda

D C O M B I N A T I O N M U L T I P L I E R S

D	TYPE	CASE	FACTOR	TYPE	TITLE
1	ADD				COMB1
		BS	1.4000	STATIC(DEAD)	
		MATI	1.4000	STATIC(DEAD)	
2	ADD				COMB2
		BS	1.2000	STATIC(DEAD)	
		MATI	1.2000	STATIC(DEAD)	
		HIDUP	1.6000	STATIC(LIVE)	
3	ADD				COMB3
		BS	1.2000	STATIC(DEAD)	
		MATI	1.2000	STATIC(DEAD)	
		HIDUP	0.5000	STATIC(LIVE)	
		WIND0	1.3000	STATIC(WIND)	
		FA0	1.3000	STATIC(WIND)	
		FS0	1.3000	STATIC(WIND)	
	ADD				COMB4
		BS	1.2000	STATIC(DEAD)	
		MATI	1.2000	STATIC(DEAD)	
		HIDUP	0.5000	STATIC(LIVE)	
		FA45	1.3000	STATIC(WIND)	
		FS45	1.3000	STATIC(WIND)	
		WIND45	1.3000	STATIC(WIND)	
	ADD				COMB5
		BS	1.2000	STATIC(DEAD)	
		MATI	1.2000	STATIC(DEAD)	
		HIDUP	0.5000	STATIC(LIVE)	
		GEMPA	1.0000	STATIC(QUAKE)	
	ADD				COMB6
		BS	0.9000	STATIC(DEAD)	
		MATI	0.9000	STATIC(DEAD)	
		WIND0	-1.3000	STATIC(WIND)	
		FA0	-1.3000	STATIC(WIND)	
		FS0	-1.3000	STATIC(WIND)	
	ADD				COMB7
		BS	0.9000	STATIC(DEAD)	
		MATI	0.9000	STATIC(DEAD)	
		WIND45	-1.3000	STATIC(WIND)	
		FA45	-1.3000	STATIC(WIND)	
		FS45	-1.3000	STATIC(WIND)	
	ADD				COMB8
		BS	0.9000	STATIC(DEAD)	
		MATI	0.9000	STATIC(DEAD)	
		GEMPA	-1.0000	STATIC(QUAKE)	
	ADD				COMB9
		BS	1.0000	STATIC(DEAD)	
		MATI	1.0000	STATIC(DEAD)	
		HIDUP	1.0000	STATIC(LIVE)	
		FA45	1.0000	STATIC(WIND)	
		FS45	1.0000	STATIC(WIND)	
		WIND45	1.3000	STATIC(WIND)	

da

ME ELEMENT FORCES

ME	LOAD	LOC	P	V2	V3	T	M2	M3
1	BS							
		0.00	0.00	-25.04	0.00	0.00	0.00	-19.51
		5.8E-01	0.00	-18.77	0.00	0.00	0.00	-6.70
		1.17	0.00	-12.51	0.00	0.00	0.00	2.44
		1.75	0.00	-6.24	0.00	0.00	0.00	7.92
		2.34	0.00	2.374E-02	0.00	0.00	0.00	9.74
1	MATI							
		0.00	0.00	0.00	0.00	0.00	0.00	0.00
		5.8E-01	0.00	0.00	0.00	0.00	0.00	0.00
		1.17	0.00	0.00	0.00	0.00	0.00	0.00
		1.75	0.00	0.00	0.00	0.00	0.00	0.00
		2.34	0.00	0.00	0.00	0.00	0.00	0.00
1	HIDUP							
		0.00	0.00	0.00	0.00	0.00	0.00	0.00
		5.8E-01	0.00	0.00	0.00	0.00	0.00	0.00
		1.17	0.00	0.00	0.00	0.00	0.00	0.00
		1.75	0.00	0.00	0.00	0.00	0.00	0.00
		2.34	0.00	0.00	0.00	0.00	0.00	0.00
1	WIND0							
		0.00	0.00	-7.692E-02	0.00	0.00	0.00	-8.995E-02
		5.8E-01	0.00	-7.692E-02	0.00	0.00	0.00	-4.497E-02
		1.17	0.00	-7.692E-02	0.00	0.00	0.00	0.00
		1.75	0.00	-7.692E-02	0.00	0.00	0.00	4.497E-02
		2.34	0.00	-7.692E-02	0.00	0.00	0.00	8.995E-02
1	WIND45							
		0.00	0.00	-1.091E-04	0.00	0.00	0.00	-1.276E-04
		5.8E-01	0.00	-1.091E-04	0.00	0.00	0.00	-6.379E-05
		1.17	0.00	-1.091E-04	0.00	0.00	0.00	0.00
		1.75	0.00	-1.091E-04	0.00	0.00	0.00	6.379E-05
		2.34	0.00	-1.091E-04	0.00	0.00	0.00	1.276E-04
1	FA0							
		0.00	0.00	1.375E-03	0.00	0.00	0.00	1.608E-03
		5.8E-01	0.00	1.375E-03	0.00	0.00	0.00	8.039E-04
		1.17	0.00	1.375E-03	0.00	0.00	0.00	0.00
		1.75	0.00	1.375E-03	0.00	0.00	0.00	-8.039E-04
		2.34	0.00	1.375E-03	0.00	0.00	0.00	-1.608E-03
1	FS0							
		0.00	0.00	3.023E-04	0.00	0.00	0.00	3.535E-04
		5.8E-01	0.00	3.023E-04	0.00	0.00	0.00	1.767E-04
		1.17	0.00	3.023E-04	0.00	0.00	0.00	0.00
		1.75	0.00	3.023E-04	0.00	0.00	0.00	-1.767E-04
		2.34	0.00	3.023E-04	0.00	0.00	0.00	-3.535E-04
1	FA45							
		0.00	0.00	8.885E-04	0.00	0.00	0.00	1.039E-03
		5.8E-01	0.00	8.885E-04	0.00	0.00	0.00	5.195E-04
		1.17	0.00	8.885E-04	0.00	0.00	0.00	0.00
		1.75	0.00	8.885E-04	0.00	0.00	0.00	-5.195E-04
		2.34	0.00	8.885E-04	0.00	0.00	0.00	-1.039E-03
1	FS45							
		0.00	0.00	1.762E-04	0.00	0.00	0.00	2.061E-04
		5.8E-01	0.00	1.762E-04	0.00	0.00	0.00	1.030E-04
		1.17	0.00	1.762E-04	0.00	0.00	0.00	0.00
		1.75	0.00	1.762E-04	0.00	0.00	0.00	-1.030E-04
		2.34	0.00	1.762E-04	0.00	0.00	0.00	-2.061E-04
1	ANTENA							
		0.00	0.00	6.357E-04	0.00	0.00	0.00	7.433E-04
		5.8E-01	0.00	6.357E-04	0.00	0.00	0.00	3.717E-04
		1.17	0.00	6.357E-04	0.00	0.00	0.00	0.00
		1.75	0.00	6.357E-04	0.00	0.00	0.00	-3.717E-04
		2.34	0.00	6.357E-04	0.00	0.00	0.00	-7.433E-04
1	GEMPA							
		0.00	0.00	0.00	0.00	0.00	0.00	0.00
		5.8E-01	0.00	0.00	0.00	0.00	0.00	0.00
		1.17	0.00	0.00	0.00	0.00	0.00	0.00
		1.75	0.00	0.00	0.00	0.00	0.00	0.00
		2.34	0.00	0.00	0.00	0.00	0.00	0.00
	COMB1							
		0.00	0.00	-30.04	0.00	0.00	0.00	-23.41
		5.8E-01	0.00	-22.53	0.00	0.00	0.00	-8.04
		1.17	0.00	-15.01	0.00	0.00	0.00	2.93

bel 6.1 Output Joint Reactions tower alternatif 2

oint	Load	F1	F2	F3	M1	M2	M3
Text	Text	Kgf	Kgf	Kgf	Kgf-m	Kgf-m	Kgf-m
63	COMB7	4,681.741	4,025.429	4,176.066	-662.238	590.810	91.592
63	COMB8	436.524	-477.266	4,944.282	-33.794	-37.479	-0.254
63	COMB9	-3,760.162	-5,024.653	6,259.390	589.717	-669.924	-92.043
94	BS	609.312	598.570	7,443.732	43.537	-42.407	-0.065
94	MATI	0.000	0.000	0.000	0.000	0.000	0.000
94	HIDUP	0.000	0.000	0.000	0.000	0.000	0.000
94	WIND0	-613.049	-6,967.253	-9,863.936	1,424.128	56.813	-119.947
94	WIND45	-5,903.049	-5,798.428	-15,429.472	1,044.471	-1,043.151	-23.532
94	FA0	0.403	-55.991	-13.706	12.392	0.215	-0.759
94	FS0	1.346	-12.034	-2.666	2.664	0.324	-0.180
94	FA45	-11.436	-32.297	-9.084	7.150	-2.495	-0.280
94	FS45	10.380	-7.267	1.566	1.645	2.295	-0.237
94	ANTENA	11.758	11.558	184.403	1.225	-1.197	-0.002
94	GEMPA	0.000	0.000	0.000	0.000	0.000	0.000
94	COMB1	731.174	718.284	8,932.478	52.245	-50.889	-0.078
94	COMB2	731.174	718.284	8,932.478	52.245	-50.889	-0.078
94	COMB3	-63.515	-8,427.577	-3,911.922	1,923.183	23.669	-157.230
94	COMB4	-6,944.162	-6,871.106	-11,135.508	1,421.490	-1,407.245	-31.343
94	COMB5	731.174	718.284	8,932.478	52.245	-50.889	-0.078
94	COMB6	1,343.070	9,684.574	19,543.759	-1,831.755	-112.725	157.094
94	COMB7	8,223.717	8,128.103	26,767.445	-1,330.061	1,318.190	31.207
94	COMB8	548.381	538.713	6,690.359	39.184	-38.167	-0.058
94	COMB9	-7,065.708	-6,978.951	-12,622.099	1,410.144	-1,398.704	-31.175

bel 5.13 Joint Displacements tower alternatif 2

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
96	COMB4	Combination	5.70E-04	5.70E-04	2.05E-05	0.0017034	0.001557	0.001535
96	COMB5	Combination	9.17E-06	9.56E-06	-8.19E-05	0.0017042	0.001561	0.00154
96	COMB6	Combination	2.11E-05	-7.43E-04	-1.26E-04	0.001705	0.001565	0.001545
96	COMB7	Combination	-5.54E-04	-5.53E-04	-1.64E-04	0.0017058	0.001569	0.00155
96	COMB8	Combination	6.88E-06	7.17E-06	-6.14E-05	0.0017066	0.001573	0.001555
96	COMB9	Combination	5.69E-04	5.67E-04	3.42E-05	0.0017074	0.001577	0.00156
97	BS	LinStatic	9.93E-06	1.02E-05	-1.01E-04	0.0017082	0.001581	0.001565
97	MATI	LinStatic	0	0	0	0.001709	0.001585	0.00157
97	HIDUP	LinStatic	0	0	0	0.0017098	0.001589	0.001575
97	WIND0	LinStatic	-1.24E-05	7.86E-04	7.67E-05	0.0017106	0.001593	0.00158
97	WIND45	LinStatic	5.93E-04	5.90E-04	1.22E-04	0.0017114	0.001597	0.001585
97	FA0	LinStatic	-1.38E-07	6.77E-06	-3.54E-07	0.0017122	0.001601	0.00159
97	FS0	LinStatic	-1.81E-07	1.46E-06	-6.76E-08	0.001713	0.001605	0.001595
97	FA45	LinStatic	1.35E-06	3.89E-06	-3.05E-07	0.0017138	0.001609	0.0016
97	FS45	LinStatic	-1.26E-06	8.99E-07	7.52E-09	0.0017146	0.001613	0.001605
97	ANTENA	LinStatic	2.38E-07	2.48E-07	-2.61E-06	0.0017154	0.001617	0.00161
97	GEMPA	LinStatic	0	0	0	0.0017162	0.001621	0.001615
97	COMB1	Combination	1.19E-05	1.22E-05	-1.22E-04	0.001717	0.001625	0.00162
97	COMB2	Combination	1.19E-05	1.22E-05	-1.22E-04	0.0017178	0.001629	0.001625
97	COMB3	Combination	-4.66E-06	1.04E-03	-2.25E-05	0.0017186	0.001633	0.00163
97	COMB4	Combination	7.83E-04	7.86E-04	3.59E-05	0.0017194	0.001637	0.001635
97	COMB5	Combination	1.19E-05	1.22E-05	-1.22E-04	0.0017202	0.001641	0.00164
97	COMB6	Combination	2.55E-05	-1.02E-03	-1.90E-04	0.001721	0.001645	0.001645
97	COMB7	Combination	-7.62E-04	-7.64E-04	-2.49E-04	0.0017218	0.001649	0.00165
97	COMB8	Combination	8.94E-06	9.19E-06	-9.12E-05	0.0017226	0.001653	0.001655
97	COMB9	Combination	7.81E-04	7.82E-04	5.63E-05	0.0017234	0.001657	0.00166
98	BS	LinStatic	1.75E-06	2.01E-06	-1.33E-04	0.0017242	0.001661	0.001665
98	MATI	LinStatic	0	0	0	0.001725	0.001665	0.00167
98	HIDUP	LinStatic	0	0	0	0.0017258	0.001669	0.001675
98	WIND0	LinStatic	-4.14E-06	1.01E-03	1.03E-04	0.0017266	0.001673	0.00168
98	WIND45	LinStatic	7.74E-04	7.71E-04	1.62E-04	0.0017274	0.001677	0.001685
98	FA0	LinStatic	-1.80E-07	8.71E-06	-4.65E-07	0.0017282	0.001681	0.00169
98	FS0	LinStatic	-2.33E-07	1.87E-06	-8.88E-08	0.001729	0.001685	0.001695
98	FA45	LinStatic	1.73E-06	5.01E-06	-4.00E-07	0.0017298	0.001689	0.0017
98	FS45	LinStatic	-1.62E-06	1.16E-06	9.77E-09	0.0017306	0.001693	0.001705
98	ANTENA	LinStatic	3.49E-08	4.76E-08	-3.45E-06	0.0017314	0.001697	0.00171
98	GEMPA	LinStatic	0	0	0	0.0017322	0.001701	0.001715
98	COMB1	Combination	2.10E-06	2.41E-06	-1.60E-04	0.001733	0.001705	0.00172
98	COMB2	Combination	2.10E-06	2.41E-06	-1.60E-04	0.0017338	0.001709	0.001725
98	COMB3	Combination	-3.81E-06	1.33E-03	-2.73E-05	0.0017346	0.001713	0.00173
98	COMB4	Combination	1.01E-03	1.01E-03	5.07E-05	0.0017354	0.001717	0.001735
98	COMB5	Combination	2.10E-06	2.41E-06	-1.60E-04	0.0017362	0.001721	0.00174
98	**COMB6**	**Combination**	**1.10E-02**	**-1.00E-02**	**-2.52E-04**	**0.001737**	**0.001725**	**0.001745**
98	COMB7	Combination	-1.00E-03	-1.01E-03	-3.31E-04	0.001728	0.001719	0.001741
98	COMB8	Combination	1.58E-06	1.81E-06	-1.20E-04	0.001719	0.001713	0.001737
98	COMB9	Combination	1.01E-03	1.01E-03	7.75E-05	0.00171	0.001707	0.001733
9	BS	LinStatic	-2.17E-05	-2.12E-05	-1.95E-04	0.001701	0.001701	0.001729
9	MATI	LinStatic	0	0	0	0.001692	0.001695	0.001725
9	HIDUP	LinStatic	0	0	0	0.001683	0.001689	0.001721
9	WIND0	LinStatic	3.22E-05	1.33E-03	1.57E-04	0.001674	0.001683	0.001717
9	WIND45	LinStatic	9.96E-04	1.05E-03	2.50E-04	0.001665	0.001677	0.001713
9	FA0	LinStatic	-2.03E-07	8.49E-06	-5.09E-07	0.001656	0.001671	0.001709
9	FS0	LinStatic	-2.27E-07	1.82E-06	-9.70E-08	0.001647	0.001665	0.001705
9	FA45	LinStatic	1.67E-06	4.83E-06	-4.50E-07	0.001638	0.001659	0.001701

bel 5.13 Joint Displacements tower alternatif 2

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
102	HIDUP	LinStatic	0	0	0	0.001143	0.001329	0.001481
102	WIND0	LinStatic	-6.22E-05	3.40E-03	2.23E-04	0.001134	0.001323	0.001477
102	WIND45	LinStatic	2.51E-03	2.57E-03	3.59E-04	0.001125	0.001317	0.001473
102	FA0	LinStatic	-3.07E-07	6.91E-06	-5.77E-07	0.001116	0.001311	0.001469
102	FS0	LinStatic	-1.40E-07	1.41E-06	-1.09E-07	0.001107	0.001305	0.001465
102	FA45	LinStatic	1.35E-06	3.48E-06	-5.33E-07	0.001098	0.001299	0.001461
102	FS45	LinStatic	-1.26E-06	7.19E-07	-4.65E-09	0.001089	0.001293	0.001457
102	ANTENA	LinStatic	1.21E-06	1.30E-06	-1.15E-05	0.00108	0.001287	0.001453
102	GEMPA	LinStatic	0	0	0	0.001071	0.001281	0.001449
102	COMB1	Combination	5.26E-05	5.38E-05	-4.92E-04	0.001062	0.001275	0.001445
102	COMB2	Combination	5.26E-05	5.38E-05	-4.92E-04	0.001053	0.001269	0.001441
102	COMB3	Combination	-2.88E-05	4.48E-03	-2.04E-04	0.001044	0.001263	0.001437
102	COMB4	Combination	3.32E-03	3.40E-03	-2.60E-05	0.001035	0.001257	0.001433
102	COMB5	Combination	5.26E-05	5.38E-05	-4.92E-04	0.001026	0.001251	0.001429
102	COMB6	Combination	1.21E-04	-4.39E-03	-6.58E-04	0.001017	0.001245	0.001425
102	COMB7	Combination	-3.23E-03	-3.30E-03	-8.35E-04	0.001008	0.001239	0.001421
102	COMB8	Combination	3.95E-05	4.04E-05	-3.69E-04	0.000999	0.001233	0.001417
102	COMB9	Combination	3.31E-03	3.39E-03	5.62E-05	0.00099	0.001227	0.001413
103	BS	LinStatic	1.68E-05	1.82E-05	-4.79E-04	0.000981	0.001221	0.001409
103	MATI	LinStatic	0	0	0	0.000972	0.001215	0.001405
103	HIDUP	LinStatic	0	0	0	0.000963	0.001209	0.001401
103	WIND0	LinStatic	-9.63E-05	3.78E-03	2.52E-04	0.000954	0.001203	0.001397
103	WIND45	LinStatic	2.83E-03	2.85E-03	4.05E-04	0.000945	0.001197	0.001393
103	FA0	LinStatic	-3.63E-07	6.40E-06	-5.96E-07	0.000936	0.001191	0.001389
103	FS0	LinStatic	-1.19E-07	1.29E-06	-1.13E-07	0.000927	0.001185	0.001385
103	FA45	LinStatic	1.23E-06	3.06E-06	-5.57E-07	0.000918	0.001179	0.001381
103	FS45	LinStatic	-1.16E-06	6.04E-07	-8.39E-09	0.000909	0.001173	0.001377
103	ANTENA	LinStatic	3.99E-07	4.65E-07	-1.37E-05	0.0009	0.001167	0.001373
03	GEMPA	LinStatic	0	0	0	0.000891	0.001161	0.001369
03	COMB1	Combination	2.02E-05	2.18E-05	-5.75E-04	0.000882	0.001155	0.001365
03	COMB2	Combination	2.02E-05	2.18E-05	-5.75E-04	0.000873	0.001149	0.001361
03	COMB3	Combination	-1.06E-04	4.94E-03	-2.48E-04	0.000864	0.001143	0.001357
03	COMB4	Combination	3.69E-03	3.73E-03	-4.97E-05	0.000855	0.001137	0.001353
03	COMB5	Combination	2.02E-05	2.18E-05	-5.75E-04	0.000846	0.001131	0.001349
03	**COMB6**	**Combination**	**3.20E-02**	**-3.10E-02**	**-7.58E-04**	**0.001737**	**0.001725**	**0.001745**
03	COMB7	Combination	-3.66E-03	-3.69E-03	-9.57E-04	0.001728	0.001719	0.001741
03	COMB8	Combination	1.51E-05	1.64E-05	-4.31E-04	0.001719	0.001713	0.001737
03	COMB9	Combination	3.69E-03	3.72E-03	4.63E-05	0.00171	0.001707	0.001733
04	BS	LinStatic	6.70E-05	6.85E-05	-5.69E-04	0.001701	0.001701	0.001729
04	MATI	LinStatic	0	0	0	0.001692	0.001695	0.001725
04	HIDUP	LinStatic	0	0	0	0.001683	0.001689	0.001721
04	WIND0	LinStatic	-1.33E-04	4.27E-03	2.72E-04	0.001674	0.001683	0.001717
04	WIND45	LinStatic	0.003191351	3.20E-03	4.36E-04	0.001665	0.001677	0.001713
04	FA0	LinStatic	-3.80E-07	5.95E-06	-6.19E-07	0.001656	0.001671	0.001709
04	FS0	LinStatic	-9.08E-08	1.17E-06	-1.17E-07	0.001647	0.001665	0.001705
04	FA45	LinStatic	1.15E-06	2.68E-06	-5.86E-07	0.001638	0.001659	0.001701
04	FS45	LinStatic	-1.07E-06	4.91E-07	-1.23E-08	0.001629	0.001653	0.001697
04	ANTENA	LinStatic	2.22E-06	2.28E-06	-1.68E-05	0.00162	0.001647	0.001693
04	GEMPA	LinStatic	0	0	0	0.001611	0.001641	0.001689
04	COMB1	Combination	8.04E-05	8.22E-05	-6.82E-04	0.001602	0.001635	0.001685
04	COMB2	Combination	8.04E-05	8.22E-05	-6.82E-04	0.001593	0.001629	0.001681
04	COMB3	Combination	-9.33E-05	5.64E-03	-3.29E-04	0.001584	0.001623	0.001677
04	COMB4	Combination	4.23E-03	4.24E-03	-1.17E-04	0.001575	0.001617	0.001673
04	COMB5	Combination	8.04E-05	8.22E-05	-6.82E-04	0.001566	0.001611	0.001669

bel 5.13 Joint Displacements tower alternatif 2

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
104	COMB6	Combination	2.34E-04	-5.49E-03	-8.65E-04	0.001557	0.001605	0.001665
104	COMB7	Combination	-4.09E-03	-4.10E-03	-1.06E-03	0.001548	0.001599	0.001661
104	COMB8	Combination	6.03E-05	6.16E-05	-5.12E-04	0.001539	0.001593	0.001657
104	COMB9	Combination	4.22E-03	4.23E-03	-2.72E-06	0.00153	0.001587	0.001653
105	BS	LinStatic	4.35E-05	4.49E-05	-6.49E-04	0.001521	0.001581	0.001649
105	MATI	LinStatic	0	0	0	0.001512	0.001575	0.001645
105	HIDUP	LinStatic	0	0	0	0.001503	0.001569	0.001641
105	WIND0	LinStatic	-1.35E-04	4.57E-03	3.00E-04	0.001494	0.001563	0.001637
105	WIND45	LinStatic	3.42E-03	3.44E-03	4.79E-04	0.001485	0.001557	0.001633
105	FA0	LinStatic	-4.25E-07	5.58E-06	-6.44E-07	0.001476	0.001551	0.001629
105	FS0	LinStatic	-7.62E-08	1.08E-06	-1.22E-07	0.001467	0.001545	0.001625
105	FA45	LinStatic	1.06E-06	2.36E-06	-6.17E-07	0.001458	0.001539	0.001621
105	FS45	LinStatic	-9.98E-07	4.04E-07	-1.62E-08	0.001449	0.001533	0.001617
105	ANTENA	LinStatic	1.27E-06	1.32E-06	-1.96E-05	0.00144	0.001527	0.001613
105	GEMPA	LinStatic	0	0	0	0.001431	0.001521	0.001609
105	COMB1	Combination	5.22E-05	5.39E-05	-7.79E-04	0.001422	0.001515	0.001605
105	COMB2	Combination	5.22E-05	5.39E-05	-7.79E-04	0.001413	0.001509	0.001601
105	COMB3	Combination	-1.24E-04	6.01E-03	-3.90E-04	0.001404	0.001503	0.001597
105	COMB4	Combination	4.50E-03	4.53E-03	-1.57E-04	0.001395	0.001497	0.001593
105	COMB5	Combination	5.22E-05	5.39E-05	-7.79E-04	0.001386	0.001491	0.001589
105	**COMB6**	**Combination**	**5.40E-02**	**-5.30E-02**	**-9.73E-04**	**0.002086**	**0.002074**	**0.002094**
105	COMB7	Combination	-4.41E-03	-4.43E-03	-1.21E-03	0.002077	0.002068	0.00209
105	COMB8	Combination	3.91E-05	4.04E-05	-5.84E-04	0.002068	0.002062	0.002086
105	COMB9	Combination	4.49E-03	4.52E-03	-2.69E-05	0.002059	0.002056	0.002082
106	BS	LinStatic	2.23E-05	2.37E-05	-7.26E-04	0.00205	0.00205	0.002078
106	MATI	LinStatic	0	0	0	0.002041	0.002044	0.002074
106	HIDUP	LinStatic	0	0	0	0.002032	0.002038	0.00207
106	WIND0	LinStatic	-1.27E-04	4.92E-03	3.23E-04	0.002023	0.002032	0.002066
106	WIND45	LinStatic	3.66E-03	3.71E-03	5.17E-04	0.002014	0.002026	0.002062
106	FA0	LinStatic	-4.70E-07	5.24E-06	-6.70E-07	0.002005	0.00202	0.002058
106	FS0	LinStatic	-6.37E-08	9.92E-07	-1.27E-07	0.001996	0.002014	0.002054
106	FA45	LinStatic	9.64E-07	2.06E-06	-6.48E-07	0.001987	0.002008	0.00205
106	FS45	LinStatic	-9.35E-07	3.24E-07	-2.00E-08	0.001978	0.002002	0.002046
106	ANTENA	LinStatic	8.82E-08	1.31E-07	-2.24E-05	0.001969	0.001996	0.002042
106	GEMPA	LinStatic	0	0	0	0.00196	0.00199	0.002038
106	COMB1	Combination	2.68E-05	2.85E-05	-8.72E-04	0.001951	0.001984	0.002034
106	COMB2	Combination	2.68E-05	2.85E-05	-8.72E-04	0.001942	0.001978	0.00203
06	COMB3	Combination	-1.39E-04	6.43E-03	-4.52E-04	0.001933	0.001972	0.002026
06	COMB4	Combination	4.79E-03	4.85E-03	-2.00E-04	0.001924	0.001966	0.002022
06	COMB5	Combination	2.68E-05	2.85E-05	-8.72E-04	0.001915	0.00196	0.002018
06	COMB6	Combination	1.86E-04	-6.38E-03	-1.07E-03	0.001906	0.001954	0.002014
06	COMB7	Combination	-4.74E-03	-4.80E-03	-1.33E-03	0.001897	0.001948	0.00201
06	COMB8	Combination	2.01E-05	2.13E-05	-6.54E-04	0.001888	0.001942	0.002006
06	COMB9	Combination	4.78E-03	4.85E-03	-5.44E-05	0.001879	0.001936	0.002002
07	BS	LinStatic	-9.33E-05	-9.19E-05	-7.93E-04	0.00187	0.00193	0.001998
07	MATI	LinStatic	0	0	0	0.001861	0.001924	0.001994
07	HIDUP	LinStatic	0	0	0	0.001852	0.001918	0.00199
07	WIND0	LinStatic	-7.92E-05	5.34E-03	3.41E-04	0.001843	0.001912	0.001986
07	WIND45	LinStatic	3.99E-03	4.09E-03	5.46E-04	0.001834	0.001906	0.001982
07	FA0	LinStatic	-5.82E-07	4.76E-06	-6.86E-07	0.001825	0.0019	0.001978
07	FS0	LinStatic	-5.77E-08	8.76E-07	-1.30E-07	0.001816	0.001894	0.001974
07	FA45	LinStatic	7.90E-07	1.63E-06	-6.68E-07	0.001807	0.001888	0.00197
07	FS45	LinStatic	-8.63E-07	2.18E-07	-2.30E-08	0.001798	0.001882	0.001966
07	ANTENA	LinStatic	-4.58E-06	-4.55E-06	-2.48E-05	0.001789	0.001876	0.001962

el 5.13 Joint Displacements tower alternatif 2

oint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
ext	Text	Text	m	m	m	Radians	Radians	Radians
10	WIND45	LinStatic	5.12E-03	5.13E-03	3.55E-04	0.001294	0.001546	0.001742
10	FA0	LinStatic	-7.11E-07	2.76E-06	-5.46E-07	0.001285	0.00154	0.001738
10	FS0	LinStatic	6.75E-08	3.48E-07	-1.03E-07	0.001276	0.001534	0.001734
10	FA45	LinStatic	4.12E-07	-1.39E-07	-5.39E-07	0.001267	0.001528	0.00173
10	FS45	LinStatic	-4.37E-07	-3.10E-07	-2.19E-08	0.001258	0.001522	0.001726
10	ANTENA	LinStatic	3.17E-06	3.14E-06	-3.65E-05	0.001249	0.001516	0.001722
10	GEMPA	LinStatic	0	0	0	0.00124	0.00151	0.001718
10	COMB1	Combination	1.21E-04	1.22E-04	-1.28E-03	0.001231	0.001504	0.001714
10	COMB2	Combination	1.21E-04	1.22E-04	-1.28E-03	0.001222	0.001498	0.00171
10	COMB3	Combination	-1.55E-04	8.94E-03	-1.00E-03	0.001213	0.001492	0.001706
10	COMB4	Combination	6.77E-03	6.79E-03	-8.21E-04	0.001204	0.001486	0.001702
10	COMB5	Combination	1.21E-04	1.22E-04	-1.28E-03	0.001195	0.00148	0.001698
10	**COMB6**	**Combination**	**9.30E-02**	**-5.20E-02**	**-1.24E-03**	**0.002086**	**0.002074**	**0.002094**
10	COMB7	Combination	-6.56E-03	-6.58E-03	-1.42E-03	0.002077	0.002068	0.00209
10	COMB8	Combination	9.04E-05	9.16E-05	-9.61E-04	0.002068	0.002062	0.002086
10	COMB9	Combination	6.75E-03	6.77E-03	-6.07E-04	0.002059	0.002056	0.002082
11	BS	LinStatic	1.70E-04	1.72E-04	-1.16E-03	0.00205	0.00205	0.002078
11	MATI	LinStatic	0	0	0	0.002041	0.002044	0.002074
11	HIDUP	LinStatic	0	0	0	0.002032	0.002038	0.00207
11	WIND0	LinStatic	-1.92E-04	7.18E-03	1.61E-04	0.002023	0.002032	0.002066
11	WIND45	LinStatic	5.48E-03	5.47E-03	2.64E-04	0.002014	0.002026	0.002062
11	FA0	LinStatic	-8.20E-07	2.14E-06	-4.58E-07	0.002005	0.00202	0.002058
11	FS0	LinStatic	8.81E-08	1.91E-07	-8.66E-08	0.001996	0.002014	0.002054
11	FA45	LinStatic	2.35E-07	-6.96E-07	-4.53E-07	0.001987	0.002008	0.00205
11	FS45	LinStatic	-3.25E-07	-4.59E-07	-1.91E-08	0.001978	0.002002	0.002046
11	ANTENA	LinStatic	6.65E-06	6.60E-06	-4.10E-05	0.001969	0.001996	0.002042
11	GEMPA	LinStatic	0	0	0	0.00196	0.00199	0.002038
11	COMB1	Combination	2.04E-04	2.06E-04	-1.39E-03	0.001951	0.001984	0.002034
11	COMB2	Combination	2.04E-04	2.06E-04	-1.39E-03	0.001942	0.001978	0.00203
11	COMB3	Combination	-4.61E-05	9.55E-03	-1.19E-03	0.001933	0.001972	0.002026
11	COMB4	Combination	7.32E-03	7.32E-03	-1.05E-03	0.001924	0.001966	0.002022
11	COMB5	Combination	2.04E-04	2.06E-04	-1.39E-03	0.001915	0.00196	0.002018
11	COMB6	Combination	4.03E-04	-9.19E-03	-1.25E-03	0.001906	0.001954	0.002014
11	COMB7	Combination	-6.97E-03	-6.96E-03	-1.39E-03	0.001897	0.001948	0.00201
11	COMB8	Combination	1.53E-04	1.54E-04	-1.05E-03	0.001888	0.001942	0.002006
11	COMB9	Combination	7.29E-03	7.28E-03	-8.19E-04	0.001879	0.001936	0.002002
2	BS	LinStatic	1.13E-04	1.14E-04	-1.24E-03	0.00187	0.00193	0.001998
2	MATI	LinStatic	0	0	0	0.001861	0.001924	0.001994
2	HIDUP	LinStatic	0	0	0	0.001852	0.001918	0.00199
2	WIND0	LinStatic	-2.26E-04	7.36E-03	1.20E-04	0.001843	0.001912	0.001986
2	WIND45	LinStatic	5.57E-03	5.58E-03	1.99E-04	0.001834	0.001906	0.001982
2	FA0	LinStatic	-8.18E-07	1.82E-06	-3.91E-07	0.001825	0.0019	0.001978
2	FS0	LinStatic	1.14E-07	1.04E-07	-7.39E-08	0.001816	0.001894	0.001974
2	FA45	LinStatic	1.89E-07	-9.82E-07	-3.89E-07	0.001807	0.001888	0.00197
2	FS45	LinStatic	-2.53E-07	-5.51E-07	-1.73E-08	0.001798	0.001882	0.001966
2	ANTENA	LinStatic	3.63E-06	3.56E-06	-4.49E-05	0.001789	0.001876	0.001962
2	GEMPA	LinStatic	0	0	0	0.00178	0.00187	0.001958
2	COMB1	Combination	1.36E-04	1.37E-04	-1.49E-03	0.001771	0.001864	0.001954
2	COMB2	Combination	1.36E-04	1.37E-04	-1.49E-03	0.001762	0.001858	0.00195
2	COMB3	Combination	-1.59E-04	9.70E-03	-1.33E-03	0.001753	0.001852	0.001946
2	COMB4	Combination	7.38E-03	7.39E-03	-1.23E-03	0.001744	0.001846	0.001942
2	COMB5	Combination	1.36E-04	1.37E-04	-1.49E-03	0.001735	0.00184	0.001938
2	**COMB6**	**Combination**	**6.40E-02**	**-8.30E-02**	**-1.27E-03**	**0.002086**	**0.002074**	**0.002094**
2	COMB7	Combination	-7.14E-03	-7.15E-03	-1.37E-03	0.002077	0.002068	0.00209

el 5.13 Joint Displacements tower alternatif 2

oint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
ext	Text	Text	m	m	m	Radians	Radians	Radians
15	COMB2	Combination	1.51E-04	1.51E-04	-1.77E-03	0.001582	0.001738	0.00187
15	COMB3	Combination	1.09E-05	1.09E-02	-1.89E-03	0.001573	0.001732	0.001866
15	COMB4	Combination	8.43E-03	8.52E-03	-1.95E-03	0.001564	0.001726	0.001862
15	COMB5	Combination	1.51E-04	1.51E-04	-1.77E-03	0.001555	0.00172	0.001858
15	**COMB6**	**Combination**	**8.30E-02**	**-8.20E-02**	**-1.22E-03**	**0.002435**	**0.002423**	**0.002443**
15	COMB7	Combination	-8.16E-03	-8.26E-03	-1.16E-03	0.002426	0.002417	0.002439
15	COMB8	Combination	1.13E-04	1.14E-04	-1.33E-03	0.002417	0.002411	0.002435
15	COMB9	Combination	8.40E-03	8.50E-03	-1.65E-03	0.002408	0.002405	0.002431
16	BS	LinStatic	1.50E-04	1.50E-04	-1.56E-03	0.002399	0.002399	0.002427
16	MATI	LinStatic	0	0	0	0.00239	0.002393	0.002423
16	HIDUP	LinStatic	0	0	0	0.002381	0.002387	0.002419
16	WIND0	LinStatic	-1.23E-04	8.23E-03	-1.64E-04	0.002372	0.002381	0.002415
16	WIND45	LinStatic	6.39E-03	6.43E-03	-2.66E-04	0.002363	0.002375	0.002411
16	FA0	LinStatic	-1.36E-06	-6.65E-07	2.19E-07	0.002354	0.002369	0.002407
16	FS0	LinStatic	1.76E-07	-5.27E-07	4.11E-08	0.002345	0.002363	0.002403
16	FA45	LinStatic	-6.21E-07	-3.30E-06	2.26E-07	0.002336	0.002357	0.002399
16	FS45	LinStatic	1.65E-07	-1.15E-06	1.16E-08	0.002327	0.002351	0.002395
16	ANTENA	LinStatic	6.76E-06	6.53E-06	-6.26E-05	0.002318	0.002345	0.002391
16	GEMPA	LinStatic	0	0	0	0.002309	0.002339	0.002387
16	COMB1	Combination	1.80E-04	1.80E-04	-1.87E-03	0.0023	0.002333	0.002383
16	COMB2	Combination	1.80E-04	1.80E-04	-1.87E-03	0.002291	0.002327	0.002379
16	COMB3	Combination	1.84E-05	1.09E-02	-2.08E-03	0.002282	0.002321	0.002375
16	COMB4	Combination	8.49E-03	8.54E-03	-2.21E-03	0.002273	0.002315	0.002371
16	COMB5	Combination	1.80E-04	1.80E-04	-1.87E-03	0.002264	0.002309	0.002367
16	COMB6	Combination	2.97E-04	-1.06E-02	-1.19E-03	0.002255	0.002303	0.002363
16	COMB7	Combination	-8.17E-03	-8.22E-03	-1.05E-03	0.002246	0.002297	0.002359
16	COMB8	Combination	1.35E-04	1.35E-04	-1.40E-03	0.002237	0.002291	0.002355
16	COMB9	Combination	8.46E-03	8.51E-03	-1.90E-03	0.002228	0.002285	0.002351
17	BS	LinStatic	1.16E-04	1.16E-04	-1.63E-03	0.002219	0.002279	0.002347
17	MATI	LinStatic	0	0	0	0.00221	0.002273	0.002343
17	HIDUP	LinStatic	0	0	0	0.002201	0.002267	0.002339
17	WIND0	LinStatic	-2.16E-04	8.06E-03	-2.31E-04	0.002192	0.002261	0.002335
17	WIND45	LinStatic	6.20E-03	6.21E-03	-3.75E-04	0.002183	0.002255	0.002331
17	FA0	LinStatic	-1.16E-06	-6.66E-07	3.96E-07	0.002174	0.002249	0.002327
17	FS0	LinStatic	2.31E-07	-5.45E-07	7.44E-08	0.002165	0.002243	0.002323
17	FA45	LinStatic	-4.42E-07	-3.28E-06	4.05E-07	0.002156	0.002237	0.002319
17	FS45	LinStatic	2.23E-07	-1.20E-06	2.06E-08	0.002147	0.002231	0.002315
17	ANTENA	LinStatic	3.92E-06	3.63E-06	-6.70E-05	0.002138	0.002225	0.002311
17	GEMPA	LinStatic	0	0	0	0.002129	0.002219	0.002307
17	COMB1	Combination	1.39E-04	1.39E-04	-1.95E-03	0.00212	0.002213	0.002303
17	COMB2	Combination	1.39E-04	1.39E-04	-1.95E-03	0.002111	0.002207	0.002299
17	COMB3	Combination	-1.43E-04	1.06E-02	-2.25E-03	0.002102	0.002201	0.002295
17	COMB4	Combination	8.20E-03	8.20E-03	-2.44E-03	0.002093	0.002195	0.002291
17	COMB5	Combination	1.39E-04	1.39E-04	-1.95E-03	0.002084	0.002189	0.002287
7	**COMB6**	**Combination**	**9.70E-02**	**-9.60E-02**	**-1.16E-03**	**0.002435**	**0.002423**	**0.002443**
7	COMB7	Combination	-7.95E-03	-7.96E-03	-9.78E-04	0.002426	0.002417	0.002439
7	COMB8	Combination	1.05E-04	1.04E-04	-1.46E-03	0.002417	0.002411	0.002435
7	COMB9	Combination	8.18E-03	8.18E-03	-2.11E-03	0.002408	0.002405	0.002431
8	BS	LinStatic	1.48E-04	1.47E-04	-1.68E-03	0.002399	0.002399	0.002427
8	MATI	LinStatic	0	0	0	0.00239	0.002393	0.002423
8	HIDUP	LinStatic	0	0	0	0.002381	0.002387	0.002419
8	WIND0	LinStatic	-1.68E-04	8.06E-03	-2.91E-04	0.002372	0.002381	0.002415
8	WIND45	LinStatic	6.26E-03	6.26E-03	-4.75E-04	0.002363	0.002375	0.002411
8	FA0	LinStatic	-1.33E-06	-9.91E-07	5.98E-07	0.002354	0.002369	0.002407

bel 5.13 Joint Displacements tower alternatif 2

oint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
222	HIDUP	LinStatic	0	0	0	0.00183	0.002136	0.002368
222	WIND0	LinStatic	1.95E-06	2.75E-03	1.05E-04	0.001821	0.00213	0.002364
222	WIND45	LinStatic	8.77E-04	2.08E-03	3.39E-05	0.001812	0.002124	0.00236
222	FA0	LinStatic	-2.02E-07	8.50E-06	-4.93E-07	0.001803	0.002118	0.002356
222	FS0	LinStatic	-2.32E-07	1.82E-06	-1.29E-07	0.001794	0.002112	0.002352
222	FA45	LinStatic	1.69E-06	4.84E-06	-2.83E-07	0.001785	0.002106	0.002348
222	FS45	LinStatic	-1.60E-06	1.12E-06	-1.52E-07	0.001776	0.0021	0.002344
222	ANTENA	LinStatic	-1.96E-07	-7.10E-07	-5.01E-06	0.001767	0.002094	0.00234
222	GEMPA	LinStatic	0	0	0	0.001758	0.002088	0.002336
222	COMB1	Combination	-1.22E-05	-1.24E-05	-2.42E-04	0.001749	0.002082	0.002332
222	COMB2	Combination	-1.22E-05	-1.24E-05	-2.42E-04	0.00174	0.002076	0.002328
222	COMB3	Combination	-1.02E-05	3.58E-03	-1.07E-04	0.001731	0.00207	0.002324
222	COMB4	Combination	1.13E-03	2.70E-03	-1.98E-04	0.001722	0.002064	0.00232
222	COMB5	Combination	-1.22E-05	-1.24E-05	-2.42E-04	0.001713	0.002058	0.002316
222	COMB6	Combination	-1.11E-05	-3.60E-03	-3.16E-04	0.001704	0.002052	0.002312
222	COMB7	Combination	-1.15E-03	-2.72E-03	-2.25E-04	0.001695	0.002046	0.002308
222	COMB8	Combination	-9.14E-06	-9.33E-06	-1.81E-04	0.001686	0.00204	0.002304
222	COMB9	Combination	1.13E-03	2.70E-03	-1.58E-04	0.001677	0.002034	0.0023
223	BS	LinStatic	8.74E-06	1.05E-05	-1.97E-04	0.001668	0.002028	0.002296
223	MATI	LinStatic	0	0	0	0.001659	0.002022	0.002292
223	HIDUP	LinStatic	0	0	0	0.00165	0.002016	0.002288
223	WIND0	LinStatic	2.92E-04	1.15E-03	3.25E-05	0.001641	0.00201	0.002284
223	WIND45	LinStatic	1.16E-03	8.78E-04	-1.25E-04	0.001632	0.002004	0.00228
223	FA0	LinStatic	-2.13E-07	8.58E-06	-2.89E-07	0.001623	0.001998	0.002276
223	FS0	LinStatic	-2.28E-07	1.84E-06	-8.98E-08	0.001614	0.001992	0.002272
23	FA45	LinStatic	1.67E-06	4.91E-06	-1.01E-07	0.001605	0.001986	0.002268
23	FS45	LinStatic	-1.58E-06	1.14E-06	-1.53E-07	0.001596	0.00198	0.002264
23	ANTENA	LinStatic	6.39E-07	1.82E-07	-4.88E-06	0.001587	0.001974	0.00226
23	GEMPA	LinStatic	0	0	0	0.001578	0.001968	0.002256
23	COMB1	Combination	1.05E-05	1.26E-05	-2.36E-04	0.001569	0.001962	0.002252
23	COMB2	Combination	1.05E-05	1.26E-05	-2.36E-04	0.00156	0.001956	0.002248
23	COMB3	Combination	3.90E-04	1.52E-03	-1.94E-04	0.001551	0.00195	0.002244
23	COMB4	Combination	1.52E-03	1.16E-03	-3.99E-04	0.001542	0.001944	0.00224
23	COMB5	Combination	1.05E-05	1.26E-05	-2.36E-04	0.001533	0.001938	0.002236
23	**COMB6**	**Combination**	**-3.60E-01**	**-3.59E-01**	**-2.19E-04**	**0.00453**	**0.004518**	**0.004538**
23	COMB7	Combination	-1.50E-03	-0.001139398	-1.44E-05	0.004521	0.004512	0.004534
23	COMB8	Combination	7.87E-06	9.46E-06	-1.77E-04	0.004512	0.004506	0.00453
23	COMB9	Combination	1.51E-03	1.16E-03	-3.60E-04	0.004503	0.0045	0.004526
24	BS	LinStatic	6.03E-06	-1.64E-05	-1.58E-04	0.004494	0.004494	0.004522
24	MATI	LinStatic	0	0	0	0.004485	0.004488	0.004518
24	HIDUP	LinStatic	0	0	0	0.004476	0.004482	0.004514
24	WIND0	LinStatic	-6.45E-06	1.07E-03	-3.21E-05	0.004467	0.004476	0.00451
24	WIND45	LinStatic	8.89E-04	7.99E-04	-1.19E-04	0.004458	0.00447	0.004506
24	FA0	LinStatic	-1.70E-07	8.64E-06	3.59E-07	0.004449	0.004464	0.004502
24	FS0	LinStatic	-2.22E-07	1.85E-06	6.18E-08	0.00444	0.004458	0.004498
24	FA45	LinStatic	1.70E-06	4.96E-06	3.27E-07	0.004431	0.004452	0.004494
24	FS45	LinStatic	-1.58E-06	1.14E-06	-3.76E-08	0.004422	0.004446	0.00449
4	ANTENA	LinStatic	5.76E-07	-3.58E-07	-3.87E-06	0.004413	0.00444	0.004486
4	GEMPA	LinStatic	0	0	0	0.004404	0.004434	0.004482
4	COMB1	Combination	7.24E-06	-1.96E-05	-1.89E-04	0.004395	0.004428	0.004478
4	COMB2	Combination	7.24E-06	-1.96E-05	-1.89E-04	0.004386	0.004422	0.004474
4	COMB3	Combination	-1.65E-06	1.38E-03	-2.30E-04	0.004377	0.004416	0.00447
4	COMB4	Combination	1.16E-03	1.03E-03	-3.44E-04	0.004368	0.00441	0.004466
4	COMB5	Combination	7.24E-06	-1.96E-05	-1.89E-04	0.004359	0.004404	0.004462

bel 5.13 Joint Displacements tower alternatif 2

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
227	GEMPA	LinStatic	0	0	0	0.003864	0.004074	0.004242
227	COMB1	Combination	2.15E-06	8.49E-07	-3.06E-03	0.003855	0.004068	0.004238
227	COMB2	Combination	2.15E-06	8.49E-07	-3.06E-03	0.003846	0.004062	0.004234
227	COMB3	Combination	-4.45E-05	5.74E-03	-2.83E-03	0.003837	0.004056	0.00423
227	COMB4	Combination	4.29E-03	4.16E-03	-2.72E-03	0.003828	0.00405	0.004226
227	COMB5	Combination	2.15E-06	8.49E-07	-3.06E-03	0.003819	0.004044	0.004222
227	**COMB6**	**Combination**	**4.90E-01**	**-4.89E-01**	**-2.54E-03**	**0.005228**	**0.005216**	**0.005236**
227	COMB7	Combination	-4.29E-03	-4.15E-03	-2.64E-03	0.005219	0.00521	0.005232
227	COMB8	Combination	1.61E-06	6.37E-07	-2.30E-03	0.00521	0.005204	0.005228
227	COMB9	Combination	4.30E-03	4.16E-03	-2.21E-03	0.005201	0.005198	0.005224
228	BS	LinStatic	1.85E-06	9.40E-07	-2.55E-03	0.005192	0.005192	0.00522
228	MATI	LinStatic	0	0	0	0.005183	0.005186	0.005216
228	HIDUP	LinStatic	0	0	0	0.005174	0.00518	0.005212
228	WIND0	LinStatic	2.03E-05	3.97E-03	1.80E-04	0.005165	0.005174	0.005208
228	WIND45	LinStatic	3.04E-03	2.94E-03	2.67E-04	0.005156	0.005168	0.005204
228	FA0	LinStatic	-5.02E-05	8.68E-05	7.10E-06	0.005147	0.005162	0.0052
228	FS0	LinStatic	-5.03E-06	1.34E-05	1.23E-07	0.005138	0.005156	0.005196
228	FA45	LinStatic	-8.63E-06	3.66E-07	-8.50E-07	0.005129	0.00515	0.005192
228	FS45	LinStatic	-2.25E-05	-3.83E-06	1.82E-06	0.00512	0.005144	0.005188
228	ANTENA	LinStatic	-5.76E-07	-5.41E-07	-1.83E-04	0.005111	0.005138	0.005184
228	GEMPA	LinStatic	0	0	0	0.005102	0.005132	0.00518
228	COMB1	Combination	2.22E-06	1.13E-06	-3.06E-03	0.005093	0.005126	0.005176
228	COMB2	Combination	2.22E-06	1.13E-06	-3.06E-03	0.005084	0.00512	0.005172
228	COMB3	Combination	-4.32E-05	5.29E-03	-2.82E-03	0.005075	0.005114	0.005168
228	COMB4	Combination	3.92E-03	3.82E-03	-2.71E-03	0.005066	0.005108	0.005164
228	COMB5	Combination	2.22E-06	1.13E-06	-3.06E-03	0.005057	0.005102	0.00516
228	**COMB6**	**Combination**	**4.60E-01**	**-4.59E-01**	**-2.54E-03**	**0.005053**	**0.005041**	**0.005061**
228	COMB7	Combination	-3.91E-03	-3.82E-03	-2.65E-03	0.005044	0.005035	0.005057
228	COMB8	Combination	1.67E-06	8.46E-07	-2.30E-03	0.005035	0.005029	0.005053
228	COMB9	Combination	3.92E-03	3.82E-03	-2.20E-03	0.005026	0.005023	0.005049
29	BS	LinStatic	-9.15E-07	-1.67E-06	-2.55E-03	0.005017	0.005017	0.005045
29	MATI	LinStatic	0	0	0	0.005008	0.005011	0.005041
29	HIDUP	LinStatic	0	0	0	0.004999	0.005005	0.005037
29	WIND0	LinStatic	-5.09E-06	3.61E-03	1.86E-04	0.00499	0.004999	0.005033
29	WIND45	LinStatic	2.73E-03	2.66E-03	2.74E-04	0.004981	0.004993	0.005029
29	FA0	LinStatic	-4.94E-05	7.66E-05	7.84E-06	0.004972	0.004987	0.005025
29	FS0	LinStatic	-4.53E-06	1.30E-05	8.69E-08	0.004963	0.004981	0.005021
29	FA45	LinStatic	-7.71E-06	1.06E-06	-8.96E-07	0.004954	0.004975	0.005017
29	FS45	LinStatic	-1.85E-05	-9.73E-06	2.16E-06	0.004945	0.004969	0.005013
29	ANTENA	LinStatic	8.82E-07	9.11E-07	-1.83E-04	0.004936	0.004963	0.005009
29	GEMPA	LinStatic	0	0	0	0.004927	0.004957	0.005005
29	COMB1	Combination	-1.10E-06	-2.01E-06	-3.06E-03	0.004918	0.004951	0.005001
29	COMB2	Combination	-1.10E-06	-2.01E-06	-3.06E-03	0.004909	0.004945	0.004997
29	COMB3	Combination	-7.78E-05	4.80E-03	-2.81E-03	0.0049	0.004939	0.004993
29	COMB4	Combination	3.52E-03	3.44E-03	-2.70E-03	0.004891	0.004933	0.004989
29	COMB5	Combination	-1.10E-06	-2.01E-06	-3.06E-03	0.004882	0.004927	0.004985
29	COMB6	Combination	7.59E-05	-4.81E-03	-2.55E-03	0.004873	0.004921	0.004981
29	COMB7	Combination	-3.52E-03	-3.44E-03	-2.65E-03	0.004864	0.004915	0.004977
29	COMB8	Combination	-8.23E-07	-1.51E-06	-2.30E-03	0.004855	0.004909	0.004973
29	COMB9	Combination	3.53E-03	3.44E-03	-2.19E-03	0.004846	0.004903	0.004969
0	BS	LinStatic	2.04E-06	1.38E-06	-2.54E-03	0.004837	0.004897	0.004965
0	MATI	LinStatic	0	0	0	0.004828	0.004891	0.004961
0	HIDUP	LinStatic	0	0	0	0.004819	0.004885	0.004957
0	WIND0	LinStatic	1.39E-05	3.21E-03	1.75E-04	0.00481	0.004879	0.004953

bel 5.13 Joint Displacements tower alternatif 2

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
230	WIND45	LinStatic	2.44E-03	2.39E-03	2.57E-04	0.004801	0.004873	0.004949
230	FA0	LinStatic	-3.75E-05	7.28E-05	7.04E-06	0.004792	0.004867	0.004945
230	FS0	LinStatic	-4.11E-06	1.17E-05	1.89E-07	0.004783	0.004861	0.004941
230	FA45	LinStatic	-6.45E-06	1.06E-06	-9.70E-07	0.004774	0.004855	0.004937
230	FS45	LinStatic	-1.77E-05	-2.55E-06	1.43E-06	0.004765	0.004849	0.004933
230	ANTENA	LinStatic	-4.13E-07	-3.91E-07	-1.83E-04	0.004756	0.004843	0.004929
230	GEMPA	LinStatic	0	0	0	0.004747	0.004837	0.004925
230	COMB1	Combination	2.44E-06	1.65E-06	-3.05E-03	0.004738	0.004831	0.004921
230	COMB2	Combination	2.44E-06	1.65E-06	-3.05E-03	0.004729	0.004825	0.004917
230	COMB3	Combination	-3.36E-05	4.29E-03	-2.82E-03	0.00472	0.004819	0.004913
230	COMB4	Combination	3.14E-03	3.10E-03	-2.72E-03	0.004711	0.004813	0.004909
230	COMB5	Combination	2.44E-06	1.65E-06	-3.05E-03	0.004702	0.004807	0.004905
230	**COMB6**	**Combination**	**4.30E-01**	**-4.29E-01**	**-2.53E-03**	**0.004704**	**0.004692**	**0.004712**
230	COMB7	Combination	-3.14E-03	-3.10E-03	-2.63E-03	0.004695	0.004686	0.004708
230	COMB8	Combination	1.83E-06	1.24E-06	-2.29E-03	0.004686	0.00468	0.004704
230	COMB9	Combination	3.15E-03	3.10E-03	-2.21E-03	0.004677	0.004674	0.0047
231	BS	LinStatic	-1.52E-05	-1.58E-05	-2.54E-03	0.004668	0.004668	0.004696
231	MATI	LinStatic	0	0	0	0.004659	0.004662	0.004692
231	HIDUP	LinStatic	0	0	0	0.00465	0.004656	0.004688
231	WIND0	LinStatic	7.65E-05	2.84E-03	1.67E-04	0.004641	0.00465	0.004684
231	WIND45	LinStatic	2.20E-03	2.17E-03	2.44E-04	0.004632	0.004644	0.00468
231	FA0	LinStatic	-1.72E-05	7.48E-05	6.11E-06	0.004623	0.004638	0.004676
231	FS0	LinStatic	-4.02E-06	9.82E-06	3.04E-07	0.004614	0.004632	0.004672
231	FA45	LinStatic	-4.73E-06	1.10E-06	-1.06E-06	0.004605	0.004626	0.004668
231	FS45	LinStatic	-1.54E-05	1.52E-05	5.95E-07	0.004596	0.00462	0.004664
231	ANTENA	LinStatic	-3.63E-06	-3.61E-06	-1.82E-04	0.004587	0.004614	0.00466
231	GEMPA	LinStatic	0	0	0	0.004578	0.004608	0.004656
231	COMB1	Combination	-1.82E-05	-1.89E-05	-3.05E-03	0.004569	0.004602	0.004652
231	COMB2	Combination	-1.82E-05	-1.89E-05	-3.05E-03	0.00456	0.004596	0.004648
231	COMB3	Combination	5.36E-05	3.78E-03	-2.82E-03	0.004551	0.00459	0.004644
231	COMB4	Combination	2.81E-03	2.82E-03	-2.73E-03	0.004542	0.004584	0.00464
231	COMB5	Combination	-1.82E-05	-1.89E-05	-3.05E-03	0.004533	0.004578	0.004636
231	COMB6	Combination	-8.55E-05	-3.82E-03	-2.51E-03	0.004524	0.004572	0.004632
231	COMB7	Combination	-2.84E-03	-2.86E-03	-2.60E-03	0.004515	0.004566	0.004628
231	COMB8	Combination	-1.37E-05	-1.42E-05	-2.28E-03	0.004506	0.00456	0.004624
231	COMB9	Combination	2.82E-03	2.82E-03	-2.22E-03	0.004497	0.004554	0.00462
232	BS	LinStatic	2.26E-06	1.92E-06	-2.53E-03	0.004488	0.004548	0.004616
232	MATI	LinStatic	0	0	0	0.004479	0.004542	0.004612
232	HIDUP	LinStatic	0	0	0	0.00447	0.004536	0.004608
232	WIND0	LinStatic	6.25E-06	2.45E-03	1.35E-04	0.004461	0.00453	0.004604
232	WIND45	LinStatic	1.84E-03	1.82E-03	1.95E-04	0.004452	0.004524	0.0046
232	FA0	LinStatic	-2.38E-05	5.28E-05	4.10E-06	0.004443	0.004518	0.004596
232	FS0	LinStatic	-2.88E-06	8.84E-06	3.81E-07	0.004434	0.004512	0.004592
232	FA45	LinStatic	-3.83E-06	1.86E-06	-1.15E-06	0.004425	0.004506	0.004588
232	FS45	LinStatic	-1.20E-05	-1.25E-06	-4.53E-07	0.004416	0.0045	0.004584
232	ANTENA	LinStatic	-2.18E-07	-2.04E-07	-1.81E-04	0.004407	0.004494	0.00458
232	GEMPA	LinStatic	0	0	0	0.004398	0.004488	0.004576
232	COMB1	Combination	2.71E-06	2.30E-06	-3.04E-03	0.004389	0.004482	0.004572
232	COMB2	Combination	2.71E-06	2.30E-06	-3.04E-03	0.00438	0.004476	0.004568
232	COMB3	Combination	-2.38E-05	3.26E-03	-2.86E-03	0.004371	0.00447	0.004564
232	COMB4	Combination	2.38E-03	2.37E-03	-2.79E-03	0.004362	0.004464	0.00456
232	COMB5	Combination	2.71E-06	2.30E-06	-3.04E-03	0.004353	0.004458	0.004556
232	**COMB6**	**Combination**	**4.14E-01**	**-4.13E-01**	**-2.48E-03**	**0.00453**	**0.004518**	**0.004538**
232	COMB7	Combination	-2.37E-03	-2.37E-03	-2.53E-03	0.004521	0.004512	0.004534

bel 5.13 Joint Displacements tower alternatif 2

oint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
ext	Text	Text	m	m	m	Radians	Radians	Radians
314	FS0	LinStatic	1.73E-07	-2.95E-07	6.42E-07	0.00354	0.003858	0.004098
314	FA45	LinStatic	-2.85E-07	-2.51E-06	3.52E-06	0.003531	0.003852	0.004094
314	FS45	LinStatic	7.47E-09	-9.81E-07	1.89E-07	0.003522	0.003846	0.00409
314	ANTENA	LinStatic	3.02E-06	1.83E-06	-1.03E-04	0.003513	0.00384	0.004086
314	GEMPA	LinStatic	0	0	0	0.003504	0.003834	0.004082
314	COMB1	Combination	8.14E-05	6.93E-05	-2.45E-03	0.003495	0.003828	0.004078
314	COMB2	Combination	8.14E-05	6.93E-05	-2.45E-03	0.003486	0.003822	0.004074
314	COMB3	Combination	-5.73E-05	6.89E-03	-0.00324115	0.003477	0.003816	0.00407
314	COMB4	Combination	5.30E-03	5.29E-03	-3.74E-03	0.003468	0.00381	0.004066
314	COMB5	Combination	8.14E-05	6.93E-05	-2.45E-03	0.003459	0.003804	0.004062
314	COMB6	Combination	5.50E-02	-5.40E-02	-1.04E-03	0.003133	0.003121	0.003141
314	COMB7	Combination	-5.16E-03	-5.17E-03	-5.44E-04	0.003124	0.003115	0.003137
314	COMB8	Combination	6.11E-05	5.20E-05	-1.83E-03	0.003115	0.003109	0.003133
314	COMB9	Combination	5.29E-03	5.28E-03	-3.33E-03	0.003106	0.003103	0.003129
315	BS	LinStatic	6.78E-05	5.77E-05	-2.00E-03	0.003097	0.003097	0.003125
315	MATI	LinStatic	0	0	0	0.003088	0.003091	0.003121
315	HIDUP	LinStatic	0	0	0	0.003079	0.003085	0.003117
315	WIND0	LinStatic	-1.06E-04	5.25E-03	-5.51E-04	0.00307	0.003079	0.003113
315	WIND45	LinStatic	4.02E-03	4.02E-03	-4.90E-04	0.003061	0.003073	0.003109
315	FA0	LinStatic	-1.17E-06	3.44E-07	2.20E-06	0.003052	0.003067	0.003105
315	FS0	LinStatic	1.73E-07	-2.95E-07	5.59E-07	0.003043	0.003061	0.003101
315	FA45	LinStatic	-2.85E-07	-2.51E-06	2.01E-06	0.003034	0.003055	0.003097
315	FS45	LinStatic	7.47E-09	-9.81E-07	5.34E-07	0.003025	0.003049	0.003093
15	ANTENA	LinStatic	3.02E-06	1.83E-06	-9.52E-05	0.003016	0.003043	0.003089
15	GEMPA	LinStatic	0	0	0	0.003007	0.003037	0.003085
15	COMB1	Combination	8.14E-05	6.93E-05	-2.40E-03	0.002998	0.003031	0.003081
15	COMB2	Combination	8.14E-05	6.93E-05	-2.40E-03	0.002989	0.003025	0.003077
15	COMB3	Combination	-5.73E-05	6.89E-03	-3.11E-03	0.00298	0.003019	0.003073
15	COMB4	Combination	5.30E-03	5.29E-03	-3.03E-03	0.002971	0.003013	0.003069
15	COMB5	Combination	8.14E-05	6.93E-05	-2.40E-03	0.002962	0.003007	0.003065
15	COMB6	Combination	2.00E-04	-6.77E-03	-1.09E-03	0.002953	0.003001	0.003061
15	COMB7	Combination	-5.16E-03	-5.17E-03	-1.17E-03	0.002944	0.002995	0.003057
15	COMB8	Combination	6.11E-05	5.20E-05	-1.80E-03	0.002935	0.002989	0.003053
15	COMB9	Combination	5.29E-03	5.28E-03	-2.63E-03	0.002926	0.002983	0.003049
16	BS	LinStatic	6.78E-05	5.77E-05	-2.00E-03	0.002917	0.002977	0.003045
16	MATI	LinStatic	0	0	0	0.002908	0.002971	0.003041
16	HIDUP	LinStatic	0	0	0	0.002899	0.002965	0.003037
16	WIND0	LinStatic	-1.06E-04	5.25E-03	-5.52E-04	0.00289	0.002959	0.003033
16	WIND45	LinStatic	4.02E-03	4.02E-03	-4.60E-04	0.002881	0.002953	0.003029
16	FA0	LinStatic	-1.17E-06	3.44E-07	2.18E-06	0.002872	0.002947	0.003025
16	FS0	LinStatic	1.73E-07	-2.95E-07	5.67E-07	0.002863	0.002941	0.003021
16	FA45	LinStatic	-2.85E-07	-2.51E-06	1.97E-06	0.002854	0.002935	0.003017
16	FS45	LinStatic	7.47E-09	-9.81E-07	5.68E-07	0.002845	0.002929	0.003013
16	ANTENA	LinStatic	3.02E-06	1.83E-06	-9.52E-05	0.002836	0.002923	0.003009
6	GEMPA	LinStatic	0	0	0	0.002827	0.002917	0.003005
6	COMB1	Combination	8.14E-05	6.93E-05	-2.40E-03	0.002818	0.002911	0.003001
6	COMB2	Combination	8.14E-05	6.93E-05	-2.40E-03	0.002809	0.002905	0.002997
6	COMB3	Combination	-5.73E-05	6.89E-03	-3.11E-03	0.0028	0.002899	0.002993
6	COMB4	Combination	5.30E-03	5.29E-03	-2.99E-03	0.002791	0.002893	0.002989
6	COMB5	Combination	8.14E-05	6.93E-05	-2.40E-03	0.002782	0.002887	0.002985
6	COMB6	Combination	2.00E-04	-6.77E-03	-1.08E-03	0.002773	0.002881	0.002981
6	COMB7	Combination	-5.16E-03	-5.17E-03	-1.20E-03	0.002764	0.002875	0.002977
6	COMB8	Combination	6.11E-05	5.20E-05	-1.80E-03	0.002755	0.002869	0.002973
6	COMB9	Combination	5.29E-03	5.28E-03	-2.60E-03	0.002746	0.002863	0.002969

bel 5.13 Joint Displacements tower alternatif 2

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
341	COMB4	Combination	1.01E-03	1.01E-03	-3.16E-03	0.002251	0.002533	0.002749
341	COMB5	Combination	2.10E-06	2.41E-06	-2.66E-03	0.002242	0.002527	0.002745
341	COMB6	Combination	7.49E-06	-1.33E-03	-2.08E-03	0.002233	0.002521	0.002741
341	COMB7	Combination	-1.00E-03	-1.01E-03	-1.49E-03	0.002224	0.002515	0.002737
341	COMB8	Combination	1.58E-06	1.81E-06	-1.99E-03	0.002215	0.002509	0.002733
341	COMB9	Combination	1.01E-03	1.01E-03	-2.71E-03	0.002206	0.002503	0.002729
342	BS	LinStatic	1.75E-06	2.01E-06	-2.22E-03	0.002197	0.002497	0.002725
342	MATI	LinStatic	0	0	0	0.002188	0.002491	0.002721
342	HIDUP	LinStatic	0	0	0	0.002179	0.002485	0.002717
342	WIND0	LinStatic	-4.14E-06	1.01E-03	-2.83E-04	0.00217	0.002479	0.002713
342	WIND45	LinStatic	7.74E-04	7.71E-04	-4.78E-04	0.002161	0.002473	0.002709
342	FA0	LinStatic	-1.80E-07	8.71E-06	7.12E-06	0.002152	0.002467	0.002705
342	FS0	LinStatic	-2.33E-07	1.87E-06	1.33E-06	0.002143	0.002461	0.002701
342	FA45	LinStatic	1.73E-06	5.01E-06	7.33E-06	0.002134	0.002455	0.002697
342	FS45	LinStatic	-1.62E-06	1.16E-06	4.07E-07	0.002125	0.002449	0.002693
342	ANTENA	LinStatic	3.49E-08	4.76E-08	-1.27E-04	0.002116	0.002443	0.002689
342	GEMPA	LinStatic	0	0	0	0.002107	0.002437	0.002685
342	COMB1	Combination	2.10E-06	2.41E-06	-2.67E-03	0.002098	0.002431	0.002681
342	COMB2	Combination	2.10E-06	2.41E-06	-2.67E-03	0.002089	0.002425	0.002677
342	COMB3	Combination	-3.81E-06	1.33E-03	-3.02E-03	0.00208	0.002419	0.002673
342	COMB4	Combination	1.01E-03	1.01E-03	-3.28E-03	0.002071	0.002413	0.002669
342	COMB5	Combination	2.10E-06	2.41E-06	-2.67E-03	0.002062	0.002407	0.002665
342	**COMB6**	**Combination**	**1.50E-01**	**-1.49E-01**	**-1.64E-03**	**0.003308**	**0.003296**	**0.003316**
342	COMB7	Combination	-1.00E-03	-1.01E-03	-1.39E-03	0.003299	0.00329	0.003312
342	COMB8	Combination	1.58E-06	1.81E-06	-2.00E-03	0.00329	0.003284	0.003308
342	COMB9	Combination	1.01E-03	1.01E-03	-2.84E-03	0.003281	0.003278	0.003304
43	BS	LinStatic	1.75E-06	2.01E-06	-2.21E-03	0.003272	0.003272	0.0033
43	MATI	LinStatic	0	0	0	0.003263	0.003266	0.003296
43	HIDUP	LinStatic	0	0	0	0.003254	0.00326	0.003292
43	WIND0	LinStatic	-4.14E-06	1.01E-03	-4.83E-04	0.003245	0.003254	0.003288
43	WIND45	LinStatic	7.74E-04	7.71E-04	-4.47E-04	0.003236	0.003248	0.003284
43	FA0	LinStatic	-1.80E-07	8.71E-06	4.28E-06	0.003227	0.003242	0.00328
43	FS0	LinStatic	-2.33E-07	1.87E-06	1.07E-06	0.003218	0.003236	0.003276
43	FA45	LinStatic	1.73E-06	5.01E-06	3.97E-06	0.003209	0.00323	0.003272
43	FS45	LinStatic	-1.62E-06	1.16E-06	9.97E-07	0.0032	0.003224	0.003268
43	ANTENA	LinStatic	3.49E-08	4.76E-08	-1.20E-04	0.003191	0.003218	0.003264
43	GEMPA	LinStatic	0	0	0	0.003182	0.003212	0.00326
43	COMB1	Combination	2.10E-06	2.41E-06	-2.65E-03	0.003173	0.003206	0.003256
43	COMB2	Combination	2.10E-06	2.41E-06	-2.65E-03	0.003164	0.0032	0.003252
43	COMB3	Combination	-3.81E-06	1.33E-03	-3.27E-03	0.003155	0.003194	0.003248
43	COMB4	Combination	1.01E-03	1.01E-03	-3.23E-03	0.003146	0.003188	0.003244
43	COMB5	Combination	2.10E-06	2.41E-06	-2.65E-03	0.003137	0.003182	0.00324
43	COMB6	Combination	7.49E-06	-1.33E-03	-1.37E-03	0.003128	0.003176	0.003236
43	COMB7	Combination	-1.00E-03	-1.01E-03	-1.42E-03	0.003119	0.00317	0.003232
43	COMB8	Combination	1.58E-06	1.81E-06	-1.99E-03	0.00311	0.003164	0.003228
43	COMB9	Combination	1.01E-03	1.01E-03	-2.79E-03	0.003101	0.003158	0.003224
4	BS	LinStatic	1.75E-06	2.01E-06	-2.21E-03	0.003092	0.003152	0.00322
4	MATI	LinStatic	0	0	0	0.003083	0.003146	0.003216
4	HIDUP	LinStatic	0	0	0	0.003074	0.00314	0.003212
4	WIND0	LinStatic	-4.14E-06	1.01E-03	-4.84E-04	0.003065	0.003134	0.003208
4	WIND45	LinStatic	7.74E-04	7.71E-04	-4.03E-04	0.003056	0.003128	0.003204
4	FA0	LinStatic	-1.80E-07	8.71E-06	4.19E-06	0.003047	0.003122	0.0032
4	FS0	LinStatic	-2.33E-07	1.87E-06	1.11E-06	0.003038	0.003116	0.003196
4	FA45	LinStatic	1.73E-06	5.01E-06	3.80E-06	0.003029	0.00311	0.003192

bel 5.13 Joint Displacements tower alternatif 2

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
377	COMB6	Combination	-1.90E-01	-1.89E-01	-1.84E-03	0.003657	0.003645	0.003665
377	COMB7	Combination	-9.63E-04	-9.84E-04	-1.66E-03	0.003648	0.003639	0.003661
377	COMB8	Combination	-4.41E-06	-2.73E-06	-2.05E-03	0.003639	0.003633	0.003657
377	COMB9	Combination	9.53E-04	9.72E-04	-2.66E-03	0.00363	0.003627	0.003653
378	BS	LinStatic	-4.90E-06	-3.04E-06	-2.26E-03	0.003621	0.003621	0.003649
378	MATI	LinStatic	0	0	0	0.003612	0.003615	0.003645
378	HIDUP	LinStatic	0	0	0	0.003603	0.003609	0.003641
378	WIND0	LinStatic	5.72E-06	9.75E-04	-2.40E-04	0.003594	0.003603	0.003637
378	WIND45	LinStatic	7.36E-04	7.33E-04	-2.50E-04	0.003585	0.003597	0.003633
378	FA0	LinStatic	1.85E-06	2.14E-05	5.39E-06	0.003576	0.003591	0.003629
378	FS0	LinStatic	-8.27E-07	5.24E-06	1.35E-06	0.003567	0.003585	0.003625
378	FA45	LinStatic	5.12E-06	1.72E-05	4.97E-06	0.003558	0.003579	0.003621
378	FS45	LinStatic	-4.05E-06	4.62E-06	1.25E-06	0.003549	0.003573	0.003617
378	ANTENA	LinStatic	-3.28E-07	-1.13E-07	-1.29E-04	0.00354	0.003567	0.003613
378	GEMPA	LinStatic	0	0	0	0.003531	0.003561	0.003609
378	COMB1	Combination	-5.88E-06	-3.64E-06	-2.71E-03	0.003522	0.003555	0.003605
378	COMB2	Combination	-5.88E-06	-3.64E-06	-2.71E-03	0.003513	0.003549	0.003601
378	COMB3	Combination	2.89E-06	1.30E-03	-3.01E-03	0.003504	0.003543	0.003597
378	COMB4	Combination	9.53E-04	9.78E-04	-3.03E-03	0.003495	0.003537	0.003593
378	COMB5	Combination	-5.88E-06	-3.64E-06	-2.71E-03	0.003486	0.003531	0.003589
378	COMB6	Combination	-1.32E-05	-1.30E-03	-1.73E-03	0.003477	0.003525	0.003585
378	COMB7	Combination	-9.63E-04	-9.84E-04	-1.71E-03	0.003468	0.003519	0.003581
378	COMB8	Combination	-4.41E-06	-2.73E-06	-2.03E-03	0.003459	0.003513	0.003577
378	COMB9	Combination	9.53E-04	9.72E-04	-2.58E-03	0.00345	0.003507	0.003573
379	BS	LinStatic	-4.90E-06	-3.04E-06	-2.26E-03	0.003441	0.003501	0.003569
379	MATI	LinStatic	0	0	0	0.003432	0.003495	0.003565
379	HIDUP	LinStatic	0	0	0	0.003423	0.003489	0.003561
379	WIND0	LinStatic	5.72E-06	9.75E-04	-2.41E-04	0.003414	0.003483	0.003557
379	WIND45	LinStatic	7.36E-04	7.33E-04	-2.25E-04	0.003405	0.003477	0.003553
379	FA0	LinStatic	1.85E-06	2.14E-05	5.27E-06	0.003396	0.003471	0.003549
379	FS0	LinStatic	-8.27E-07	5.24E-06	1.40E-06	0.003387	0.003465	0.003545
379	FA45	LinStatic	5.12E-06	1.72E-05	4.73E-06	0.003378	0.003459	0.003541
379	FS45	LinStatic	-4.05E-06	4.62E-06	1.44E-06	0.003369	0.003453	0.003537
379	ANTENA	LinStatic	-3.28E-07	-1.13E-07	-1.29E-04	0.00336	0.003447	0.003533
379	GEMPA	LinStatic	0	0	0	0.003351	0.003441	0.003529
379	COMB1	Combination	-5.88E-06	-3.64E-06	-2.71E-03	0.003342	0.003435	0.003525
379	COMB2	Combination	-5.88E-06	-3.64E-06	-2.71E-03	0.003333	0.003429	0.003521
379	COMB3	Combination	2.89E-06	1.30E-03	-3.01E-03	0.003324	0.003423	0.003517
379	COMB4	Combination	9.53E-04	9.78E-04	-2.99E-03	0.003315	0.003417	0.003513
379	COMB5	Combination	-5.88E-06	-3.64E-06	-2.71E-03	0.003306	0.003411	0.003509
379	COMB6	Combination	-1.32E-05	-1.30E-03	-1.73E-03	0.003297	0.003405	0.003505
379	COMB7	Combination	-9.63E-04	-9.84E-04	-1.75E-03	0.003288	0.003399	0.003501
379	COMB8	Combination	-4.41E-06	-2.73E-06	-2.03E-03	0.003279	0.003393	0.003497
379	COMB9	Combination	9.53E-04	9.72E-04	-2.54E-03	0.00327	0.003387	0.003493
380	BS	LinStatic	-4.90E-06	-3.04E-06	-2.26E-03	0.003261	0.003381	0.003489
380	MATI	LinStatic	0	0	0	0.003252	0.003375	0.003485
380	HIDUP	LinStatic	0	0	0	0.003243	0.003369	0.003481
380	WIND0	LinStatic	5.72E-06	9.75E-04	-1.83E-04	0.003234	0.003363	0.003477
380	WIND45	LinStatic	7.36E-04	7.33E-04	-7.50E-05	0.003225	0.003357	0.003473
380	FA0	LinStatic	1.85E-06	2.14E-05	5.70E-06	0.003216	0.003351	0.003469
380	FS0	LinStatic	-8.27E-07	5.24E-06	1.97E-06	0.003207	0.003345	0.003465
380	FA45	LinStatic	5.12E-06	1.72E-05	4.26E-06	0.003198	0.003339	0.003461
380	FS45	LinStatic	-4.05E-06	4.62E-06	2.85E-06	0.003189	0.003333	0.003457
380	ANTENA	LinStatic	-3.28E-07	-1.13E-07	-1.36E-04	0.00318	0.003327	0.003453

bel 5.13 Joint Displacements tower alternatif 2

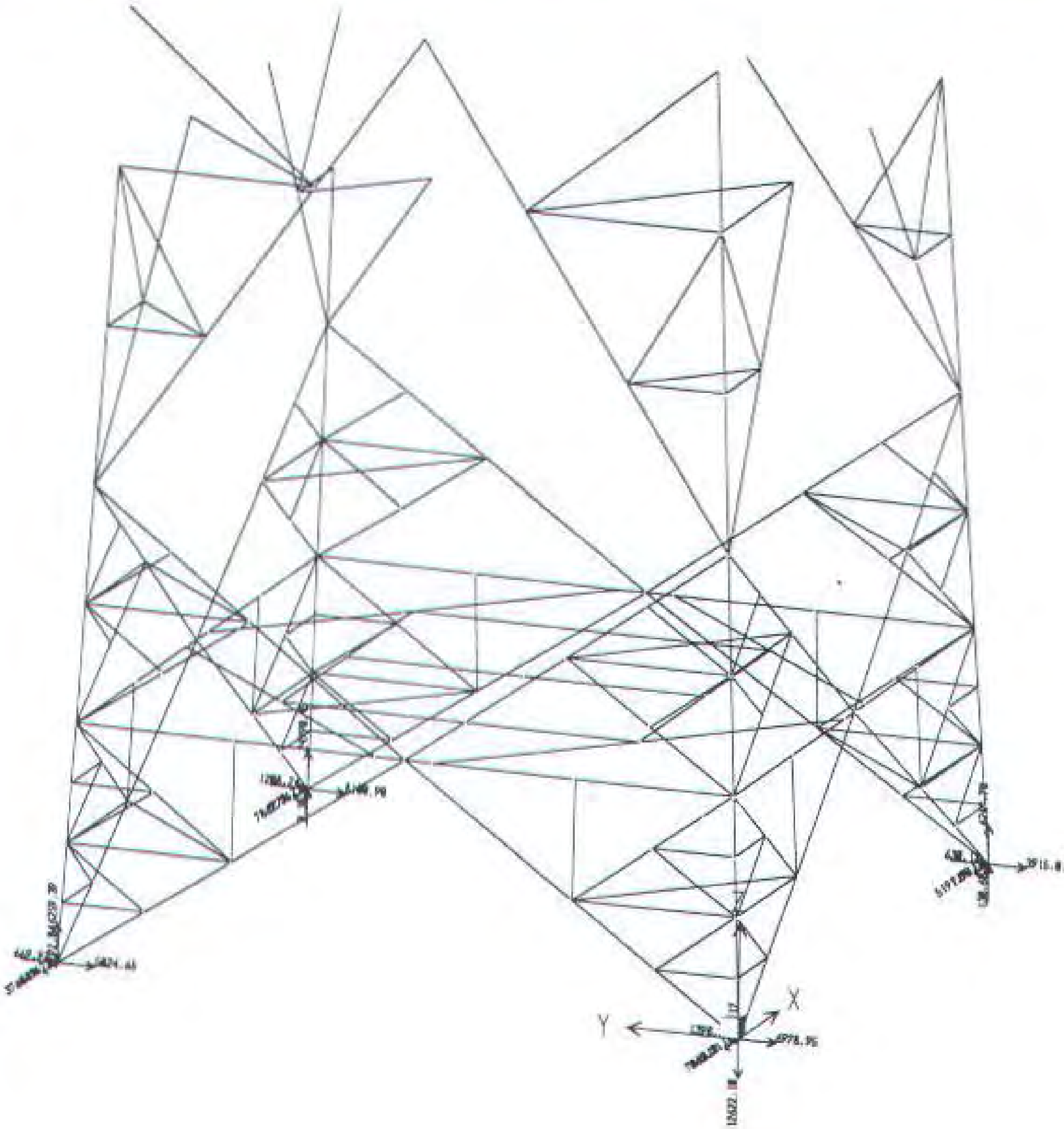
Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
405	WIND45	LinStatic	1.17E-03	1.17E-03	-1.44E-04	0.002685	0.002997	0.003233
405	FA0	LinStatic	1.15E-05	8.19E-05	-1.62E-06	0.002676	0.002991	0.003229
405	FS0	LinStatic	-3.64E-06	2.12E-05	-3.01E-07	0.002667	0.002985	0.003225
405	FA45	LinStatic	2.12E-05	7.49E-05	-2.42E-06	0.002658	0.002979	0.003221
405	FS45	LinStatic	-1.56E-05	2.10E-05	-4.66E-07	0.002649	0.002973	0.003217
405	ANTENA	LinStatic	-7.16E-07	-2.98E-07	-1.63E-04	0.00264	0.002967	0.003213
405	GEMPA	LinStatic	0	0	0	0.002631	0.002961	0.003209
405	COMB1	Combination	-1.44E-05	-1.01E-05	-2.89E-03	0.002622	0.002955	0.003205
405	COMB2	Combination	-1.44E-05	-1.01E-05	-2.89E-03	0.002613	0.002949	0.003201
405	COMB3	Combination	1.74E-05	2.17E-03	-3.00E-03	0.002604	0.002943	0.003197
405	COMB4	Combination	1.51E-03	1.63E-03	-3.08E-03	0.002595	0.002937	0.003193
405	COMB5	Combination	-1.44E-05	-1.01E-05	-2.89E-03	0.002586	0.002931	0.003189
405	**COMB6**	**Combination**	**-2.20E-01**	**-2.19E-01**	**-2.08E-03**	**0.003657**	**0.003645**	**0.003665**
405	COMB7	Combination	-1.54E-03	-1.65E-03	-1.97E-03	0.003648	0.003639	0.003661
405	COMB8	Combination	-1.08E-05	-7.61E-06	-2.17E-03	0.003639	0.003633	0.003657
405	COMB9	Combination	1.51E-03	1.60E-03	-2.60E-03	0.00363	0.003627	0.003653
406	BS	LinStatic	-1.20E-05	-8.45E-06	-2.37E-03	0.003621	0.003621	0.003649
406	MATI	LinStatic	0	0	0	0.003612	0.003615	0.003645
406	HIDUP	LinStatic	0	0	0	0.003603	0.003609	0.003641
406	WIND0	LinStatic	1.66E-05	1.57E-03	-2.93E-05	0.003594	0.003603	0.003637
406	WIND45	LinStatic	1.17E-03	1.17E-03	-7.81E-05	0.003585	0.003597	0.003633
406	FA0	LinStatic	1.15E-05	8.19E-05	3.76E-06	0.003576	0.003591	0.003629
406	FS0	LinStatic	-3.64E-06	2.12E-05	9.35E-07	0.003567	0.003585	0.003625
406	FA45	LinStatic	2.12E-05	7.49E-05	3.03E-06	0.003558	0.003579	0.003621
406	FS45	LinStatic	-1.56E-05	2.10E-05	8.10E-07	0.003549	0.003573	0.003617
406	ANTENA	LinStatic	-7.16E-07	-2.98E-07	-1.53E-04	0.00354	0.003567	0.003613
406	GEMPA	LinStatic	0	0	0	0.003531	0.003561	0.003609
406	COMB1	Combination	-1.44E-05	-1.01E-05	-2.84E-03	0.003522	0.003555	0.003605
406	COMB2	Combination	-1.44E-05	-1.01E-05	-2.84E-03	0.003513	0.003549	0.003601
406	COMB3	Combination	1.74E-05	2.17E-03	-2.88E-03	0.003504	0.003543	0.003597
406	COMB4	Combination	1.51E-03	1.63E-03	-2.94E-03	0.003495	0.003537	0.003593
406	COMB5	Combination	-1.44E-05	-1.01E-05	-2.84E-03	0.003486	0.003531	0.003589
406	COMB6	Combination	-4.26E-05	-2.18E-03	-2.10E-03	0.003477	0.003525	0.003585
406	COMB7	Combination	-1.54E-03	-1.65E-03	-2.04E-03	0.003468	0.003519	0.003581
406	COMB8	Combination	-1.08E-05	-7.61E-06	-2.13E-03	0.003459	0.003513	0.003577
406	COMB9	Combination	1.51E-03	1.60E-03	-2.47E-03	0.00345	0.003507	0.003573
407	BS	LinStatic	3.85E-06	-2.31E-05	-2.43E-03	0.003441	0.003501	0.003569
407	MATI	LinStatic	0	0	0	0.003432	0.003495	0.003565
407	HIDUP	LinStatic	0	0	0	0.003423	0.003489	0.003561
407	WIND0	LinStatic	-1.54E-06	1.61E-03	-6.62E-05	0.003414	0.003483	0.003557
407	WIND45	LinStatic	1.16E-03	1.19E-03	-8.64E-05	0.003405	0.003477	0.003553
407	FA0	LinStatic	9.71E-06	7.13E-05	1.31E-06	0.003396	0.003471	0.003549
407	FS0	LinStatic	-2.91E-06	1.82E-05	-1.22E-07	0.003387	0.003465	0.003545
407	FA45	LinStatic	1.89E-05	6.36E-05	6.91E-09	0.003378	0.003459	0.003541
407	FS45	LinStatic	-1.32E-05	1.76E-05	-5.21E-07	0.003369	0.003453	0.003537
407	ANTENA	LinStatic	1.60E-06	-2.33E-06	-1.66E-04	0.00336	0.003447	0.003533
407	GEMPA	LinStatic	0	0	0	0.003351	0.003441	0.003529
407	COMB1	Combination	4.62E-06	-2.78E-05	-2.91E-03	0.003342	0.003435	0.003525
407	COMB2	Combination	4.62E-06	-2.78E-05	-2.91E-03	0.003333	0.003429	0.003521
407	COMB3	Combination	1.15E-05	2.18E-03	-3.00E-03	0.003324	0.003423	0.003517
407	COMB4	Combination	1.53E-03	1.62E-03	-3.03E-03	0.003315	0.003417	0.003513
407	COMB5	Combination	4.62E-06	-2.78E-05	-2.91E-03	0.003306	0.003411	0.003509
407	COMB6	Combination	-3.37E-06	-2.23E-03	-2.10E-03	0.003297	0.003405	0.003505
407	COMB7	Combination	-1.52E-03	-1.67E-03	-2.07E-03	0.003288	0.003399	0.003501

bel 5.13 Joint Displacements tower alternatif 2

oint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
440	COMB2	Combination	-1.42E-05	-9.95E-06	-2.92E-03	0.002793	0.003069	0.003281
440	COMB3	Combination	1.58E-05	2.16E-03	-3.02E-03	0.002784	0.003063	0.003277
440	COMB4	Combination	1.52E-03	1.62E-03	-3.08E-03	0.002775	0.003057	0.003273
440	COMB5	Combination	-1.42E-05	-9.95E-06	-2.92E-03	0.002766	0.003051	0.003269
440	COMB6	Combination	-4.06E-05	-2.18E-03	-2.09E-03	0.002757	0.003045	0.003265
440	COMB7	Combination	-1.54E-03	-1.64E-03	-0.00202703	0.002748	0.003039	0.003261
440	COMB8	Combination	-1.06E-05	-7.46E-06	-2.19E-03	0.002739	0.003033	0.003257
440	COMB9	Combination	1.52E-03	1.60E-03	-2.59E-03	0.00273	0.003027	0.003253
441	BS	LinStatic	-1.18E-05	-8.29E-06	-2.44E-03	0.002721	0.003021	0.003249
441	MATI	LinStatic	0	0	0	0.002712	0.003015	0.003245
441	HIDUP	LinStatic	0	0	0	0.002703	0.003009	0.003241
441	WIND0	LinStatic	1.63E-05	1.58E-03	-6.01E-05	0.002694	0.003003	0.003237
441	WIND45	LinStatic	1.17E-03	1.17E-03	-1.08E-04	0.002685	0.002997	0.003233
441	FA0	LinStatic	1.01E-05	7.44E-05	-3.31E-06	0.002676	0.002991	0.003229
441	FS0	LinStatic	-3.30E-06	1.92E-05	-6.12E-07	0.002667	0.002985	0.003225
441	FA45	LinStatic	1.91E-05	6.74E-05	-4.54E-06	0.002658	0.002979	0.003221
441	FS45	LinStatic	-1.42E-05	1.89E-05	-7.38E-07	0.002649	0.002973	0.003217
441	ANTENA	LinStatic	-7.08E-07	-2.88E-07	-1.67E-04	0.00264	0.002967	0.003213
441	GEMPA	LinStatic	0	0	0	0.002631	0.002961	0.003209
441	COMB1	Combination	-1.42E-05	-9.95E-06	-2.92E-03	0.002622	0.002955	0.003205
441	COMB2	Combination	-1.42E-05	-9.95E-06	-2.92E-03	0.002613	0.002949	0.003201
441	COMB3	Combination	1.58E-05	2.16E-03	-3.01E-03	0.002604	0.002943	0.003197
441	COMB4	Combination	1.52E-03	1.62E-03	-3.07E-03	0.002595	0.002937	0.003193
441	COMB5	Combination	-1.42E-05	-9.95E-06	-2.92E-03	0.002586	0.002931	0.003189
441	~~COMB6~~	~~Combination~~	~~-2.40E-01~~	~~-2.39E-01~~	~~-2.11E-03~~	~~0.003657~~	~~0.003645~~	~~0.003665~~
441	COMB7	Combination	-1.54E-03	-1.64E-03	-2.05E-03	0.003648	0.003639	0.003661
441	COMB8	Combination	-1.06E-05	-7.46E-06	-2.19E-03	0.003639	0.003633	0.003657
441	COMB9	Combination	1.52E-03	1.60E-03	-2.58E-03	0.00363	0.003627	0.003653
42	BS	LinStatic	-1.18E-05	-8.29E-06	-2.43E-03	0.003621	0.003621	0.003649
42	MATI	LinStatic	0	0	0	0.003612	0.003615	0.003645
42	HIDUP	LinStatic	0	0	0	0.003603	0.003609	0.003641
42	WIND0	LinStatic	1.63E-05	1.58E-03	-7.44E-05	0.003594	0.003603	0.003637
42	WIND45	LinStatic	1.17E-03	1.17E-03	-1.11E-04	0.003585	0.003597	0.003633
42	FA0	LinStatic	1.01E-05	7.44E-05	-1.12E-06	0.003576	0.003591	0.003629
42	FS0	LinStatic	-3.30E-06	1.92E-05	-3.50E-07	0.003567	0.003585	0.003625
42	FA45	LinStatic	1.91E-05	6.74E-05	-2.12E-06	0.003558	0.003579	0.003621
42	FS45	LinStatic	-1.42E-05	1.89E-05	-5.69E-07	0.003549	0.003573	0.003617
42	ANTENA	LinStatic	-7.08E-07	-2.88E-07	-1.65E-04	0.00354	0.003567	0.003613
42	GEMPA	LinStatic	0	0	0	0.003531	0.003561	0.003609
42	COMB1	Combination	-1.42E-05	-9.95E-06	-2.92E-03	0.003522	0.003555	0.003605
42	COMB2	Combination	-1.42E-05	-9.95E-06	-2.92E-03	0.003513	0.003549	0.003601
42	COMB3	Combination	1.58E-05	2.16E-03	-3.02E-03	0.003504	0.003543	0.003597
42	COMB4	Combination	1.52E-03	1.62E-03	-3.07E-03	0.003495	0.003537	0.003593
42	COMB5	Combination	-1.42E-05	-9.95E-06	-2.92E-03	0.003486	0.003531	0.003589
42	COMB6	Combination	-4.06E-05	-2.18E-03	-2.09E-03	0.003477	0.003525	0.003585
42	COMB7	Combination	-1.54E-03	-1.64E-03	-2.04E-03	0.003468	0.003519	0.003581
42	COMB8	Combination	-1.06E-05	-7.46E-06	-2.19E-03	0.003459	0.003513	0.003577
42	COMB9	Combination	1.52E-03	1.60E-03	-2.58E-03	0.00345	0.003507	0.003573
3	BS	LinStatic	-5.52E-05	5.38E-05	-2.50E-03	0.003441	0.003501	0.003569
3	MATI	LinStatic	0	0	0	0.003432	0.003495	0.003565
3	HIDUP	LinStatic	0	0	0	0.003423	0.003489	0.003561
3	WIND0	LinStatic	1.58E-04	1.14E-03	6.29E-05	0.003414	0.003483	0.003557
3	WIND45	LinStatic	9.36E-04	1.00E-03	-8.52E-05	0.003405	0.003477	0.003553
3	FA0	LinStatic	1.52E-05	1.31E-05	7.62E-06	0.003396	0.003471	0.003549

bel 5.13 Joint Displacements tower alternatif 2

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
463	BS	LinStatic	1.75E-06	2.01E-06	-2.51E-03	0.002901	0.003141	0.003329
463	MATI	LinStatic	0	0	0	0.002892	0.003135	0.003325
463	HIDUP	LinStatic	0	0	0	0.002883	0.003129	0.003321
463	WIND0	LinStatic	-4.14E-06	1.01E-03	9.16E-05	0.002874	0.003123	0.003317
463	WIND45	LinStatic	7.74E-04	7.71E-04	1.23E-04	0.002865	0.003117	0.003313
463	FA0	LinStatic	-1.80E-07	8.71E-06	1.25E-06	0.002856	0.003111	0.003309
463	FS0	LinStatic	-2.33E-07	1.87E-06	2.79E-07	0.002847	0.003105	0.003305
463	FA45	LinStatic	1.73E-06	5.01E-06	-2.10E-06	0.002838	0.003099	0.003301
463	FS45	LinStatic	-1.62E-06	1.16E-06	-1.50E-06	0.002829	0.003093	0.003297
463	ANTENA	LinStatic	3.49E-08	4.76E-08	-1.77E-04	0.00282	0.003087	0.003293
463	GEMPA	LinStatic	0	0	0	0.002811	0.003081	0.003289
463	COMB1	Combination	2.10E-06	2.41E-06	-3.01E-03	0.002802	0.003075	0.003285
463	COMB2	Combination	2.10E-06	2.41E-06	-3.01E-03	0.002793	0.003069	0.003281
463	COMB3	Combination	-3.81E-06	1.33E-03	-2.89E-03	0.002784	0.003063	0.003277
463	COMB4	Combination	1.01E-03	1.01E-03	-2.86E-03	0.002775	0.003057	0.003273
463	COMB5	Combination	2.10E-06	2.41E-06	-3.01E-03	0.002766	0.003051	0.003269
463	**COMB6**	**Combination**	**3.50E-01**	**-3.49E-01**	**-2.39E-03**	**0.00418**	**0.004168**	**0.004186**
463	COMB7	Combination	-1.00E-03	-1.01E-03	-2.41E-03	0.004171	0.004162	0.004184
463	COMB8	Combination	1.58E-06	1.81E-06	-2.26E-03	0.004162	0.004156	0.00418
463	COMB9	Combination	1.01E-03	1.01E-03	-2.35E-03	0.004153	0.00415	0.004176
464	BS	LinStatic	1.75E-06	2.01E-06	-0.00251142	0.004144	0.004144	0.004172
464	MATI	LinStatic	0	0	0	0.004135	0.004138	0.004168
464	HIDUP	LinStatic	0	0	0	0.004126	0.004132	0.004164
464	WIND0	LinStatic	-4.14E-06	1.01E-03	9.93E-05	0.004117	0.004126	0.00416
464	WIND45	LinStatic	7.74E-04	7.71E-04	-9.03E-05	0.004108	0.00412	0.004156
464	FA0	LinStatic	-1.80E-07	8.71E-06	7.19E-06	0.004099	0.004114	0.004152
464	FS0	LinStatic	-2.33E-07	1.87E-06	8.62E-07	0.00409	0.004108	0.004148
464	FA45	LinStatic	1.73E-06	5.01E-06	-2.60E-07	0.004081	0.004102	0.004144
464	FS45	LinStatic	-1.62E-06	1.16E-06	4.78E-07	0.004072	0.004096	0.00414
464	ANTENA	LinStatic	3.49E-08	4.76E-08	-1.77E-04	0.004063	0.00409	0.004136
464	GEMPA	LinStatic	0	0	0	0.004054	0.004084	0.004132
464	COMB1	Combination	2.10E-06	2.41E-06	-3.01E-03	0.004045	0.004078	0.004128
464	COMB2	Combination	2.10E-06	2.41E-06	-3.01E-03	0.004036	0.004072	0.004124
464	COMB3	Combination	-3.81E-06	1.33E-03	-2.87E-03	0.004027	0.004066	0.00412
464	COMB4	Combination	1.01E-03	1.01E-03	-3.13E-03	0.004018	0.00406	0.004116
464	COMB5	Combination	2.10E-06	2.41E-06	-3.01E-03	0.004009	0.004054	0.004112
464	COMB6	Combination	7.49E-06	-1.33E-03	-2.40E-03	0.004	0.004048	0.004108
464	COMB7	Combination	-1.00E-03	-1.01E-03	-2.14E-03	0.003991	0.004042	0.004104
464	COMB8	Combination	1.58E-06	1.81E-06	-2.26E-03	0.003982	0.004036	0.0041
464	COMB9	Combination	1.01E-03	1.01E-03	-2.63E-03	0.003973	0.00403	0.004096
465	BS	LinStatic	1.75E-06	2.01E-06	-2.51E-03	0.003964	0.004024	0.004092
465	MATI	LinStatic	0	0	0	0.003955	0.004018	0.004088
465	HIDUP	LinStatic	0	0	0	0.003946	0.004012	0.004084
465	WIND0	LinStatic	-4.14E-06	1.01E-03	-2.11E-04	0.003937	0.004006	0.00408
465	WIND45	LinStatic	7.74E-04	7.71E-04	-3.24E-04	0.003928	0.004	0.004076
465	FA0	LinStatic	-1.80E-07	8.71E-06	-1.24E-06	0.003919	0.003994	0.004072
465	FS0	LinStatic	-2.33E-07	1.87E-06	-2.90E-07	0.00391	0.003988	0.004068
465	FA45	LinStatic	1.73E-06	5.01E-06	2.22E-06	0.003901	0.003982	0.004064
465	FS45	LinStatic	-1.62E-06	1.16E-06	1.51E-06	0.003892	0.003976	0.00406
465	ANTENA	LinStatic	3.49E-08	4.76E-08	-1.77E-04	0.003883	0.00397	0.004056
465	GEMPA	LinStatic	0	0	0	0.003874	0.003964	0.004052
465	COMB1	Combination	2.10E-06	2.41E-06	-3.01E-03	0.003865	0.003958	0.004048
465	COMB2	Combination	2.10E-06	2.41E-06	-3.01E-03	0.003856	0.003952	0.004044
465	COMB3	Combination	-3.81E-06	1.33E-03	-3.29E-03	0.003847	0.003946	0.00404



bel 5.13 Joint Displacements tower alternatif 2

Joint	OutputCase	CaseType	U1	U2	U3	R1	R2	R3
Text	Text	Text	m	m	m	Radians	Radians	Radians
490	FS45	LinStatic	-5.12E-06	1.96E-07	-1.49E-06	0.003352	0.003616	0.00382
490	ANTENA	LinStatic	6.97E-08	8.18E-08	-1.78E-04	0.003343	0.00361	0.003816
490	GEMPA	LinStatic	0	0	0	0.003334	0.003604	0.003812
490	COMB1	Combination	3.19E-06	3.30E-06	-3.02E-03	0.003325	0.003598	0.003808
490	COMB2	Combination	3.19E-06	3.30E-06	-3.02E-03	0.003316	0.003592	0.003804
490	COMB3	Combination	-1.62E-05	2.07E-03	-2.89E-03	0.003307	0.003586	0.0038
490	COMB4	Combination	1.52E-03	1.53E-03	-2.85E-03	0.003298	0.00358	0.003796
490	COMB5	Combination	3.19E-06	3.30E-06	-3.02E-03	0.003289	0.003574	0.003792
490	**COMB6**	**Combination**	**3.20E-01**	**-3.19E-01**	**-2.40E-03**	**0.004006**	**0.003994**	**0.004014**
490	COMB7	Combination	-1.52E-03	-1.52E-03	-2.44E-03	0.003997	0.003988	0.00401
490	COMB8	Combination	2.39E-06	2.48E-06	-2.27E-03	0.003988	0.003982	0.004006
490	COMB9	Combination	1.53E-03	1.53E-03	-2.34E-03	0.003979	0.003976	0.004002
491	BS	LinStatic	2.66E-06	2.75E-06	-2.52E-03	0.00397	0.00397	0.003998
491	MATI	LinStatic	0	0	0	0.003961	0.003964	0.003994
491	HIDUP	LinStatic	0	0	0	0.003952	0.003958	0.00399
491	WIND0	LinStatic	-5.10E-06	1.56E-03	7.08E-05	0.003943	0.003952	0.003986
491	WIND45	LinStatic	1.18E-03	1.17E-03	6.82E-05	0.003934	0.003946	0.003982
491	FA0	LinStatic	-8.67E-06	2.35E-05	2.12E-06	0.003925	0.00394	0.003978
491	FS0	LinStatic	-1.16E-06	4.14E-06	3.79E-07	0.003916	0.003934	0.003974
491	FA45	LinStatic	-3.77E-07	3.40E-06	-1.14E-06	0.003907	0.003928	0.00397
491	FS45	LinStatic	-5.12E-06	1.96E-07	-9.74E-07	0.003898	0.003922	0.003966
491	ANTENA	LinStatic	6.97E-08	8.18E-08	-1.78E-04	0.003889	0.003916	0.003962
491	GEMPA	LinStatic	0	0	0	0.00388	0.00391	0.003958
491	COMB1	Combination	3.19E-06	3.30E-06	-3.03E-03	0.003871	0.003904	0.003954
491	COMB2	Combination	3.19E-06	3.30E-06	-3.03E-03	0.003862	0.003898	0.00395
491	COMB3	Combination	-1.62E-05	2.07E-03	-2.93E-03	0.003853	0.003892	0.003946
491	COMB4	Combination	1.52E-03	1.53E-03	-2.94E-03	0.003844	0.003886	0.003942
491	COMB5	Combination	3.19E-06	3.30E-06	-3.03E-03	0.003835	0.00388	0.003938
491	COMB6	Combination	2.18E-05	-2.06E-03	-2.37E-03	0.003826	0.003874	0.003934
491	COMB7	Combination	-1.52E-03	-1.52E-03	-2.36E-03	0.003817	0.003868	0.00393
491	COMB8	Combination	2.39E-06	2.48E-06	-2.27E-03	0.003808	0.003862	0.003926
491	COMB9	Combination	1.53E-03	1.53E-03	-2.44E-03	0.003799	0.003856	0.003922
92	BS	LinStatic	2.66E-06	2.75E-06	-2.52E-03	0.00379	0.00385	0.003918
92	MATI	LinStatic	0	0	0	0.003781	0.003844	0.003914
92	HIDUP	LinStatic	0	0	0	0.003772	0.003838	0.00391
92	WIND0	LinStatic	-5.10E-06	1.56E-03	7.07E-05	0.003763	0.003832	0.003906
92	WIND45	LinStatic	1.18E-03	1.17E-03	-6.53E-05	0.003754	0.003826	0.003902
92	FA0	LinStatic	-8.67E-06	2.35E-05	5.33E-06	0.003745	0.00382	0.003898
92	FS0	LinStatic	-1.16E-06	4.14E-06	7.10E-07	0.003736	0.003814	0.003894
92	FA45	LinStatic	-3.77E-07	3.40E-06	-2.01E-07	0.003727	0.003808	0.00389
92	FS45	LinStatic	-5.12E-06	1.96E-07	2.44E-07	0.003718	0.003802	0.003886
92	ANTENA	LinStatic	6.97E-08	8.18E-08	-1.78E-04	0.003709	0.003796	0.003882
92	GEMPA	LinStatic	0	0	0	0.0037	0.00379	0.003878
92	COMB1	Combination	3.19E-06	3.30E-06	-3.03E-03	0.003691	0.003784	0.003874
92	COMB2	Combination	3.19E-06	3.30E-05	-3.03E-03	0.003682	0.003778	0.00387
92	COMB3	Combination	-1.62E-05	2.07E-03	-2.93E-03	0.003673	0.003772	0.003866
92	COMB4	Combination	1.52E-03	1.53E-03	-3.11E-03	0.003664	0.003766	0.003862
92	COMB5	Combination	3.19E-06	3.30E-06	-3.03E-03	0.003655	0.00376	0.003858
92	COMB6	Combination	2.18E-05	-2.06E-03	-2.37E-03	0.003646	0.003754	0.003854
92	COMB7	Combination	-1.52E-03	-1.52E-03	-2.19E-03	0.003637	0.003748	0.00385
92	COMB8	Combination	2.39E-06	2.48E-06	-2.27E-03	0.003628	0.003742	0.003846
92	COMB9	Combination	1.53E-03	1.53E-03	-2.61E-03	0.003619	0.003736	0.003842
93	BS	LinStatic	2.66E-06	2.75E-06	-2.52E-03	0.00361	0.00373	0.003838
93	MATI	LinStatic	0	0	0	0.003601	0.003724	0.003834

SR.IMP-19/AK.07-07/2003.

LAPORAN PENYELIDIKAN TANAH

Proyek : Tower Mobile 8 Telecom.

Lokasi : Bangil, Jawa Timur.

Relasi : P.T. Imperium Mitra Persada, Surabaya.

TESTANA ENGINEERING, INC.

SURABAYA

te

TESTANA ENGINEERING, INC.

Soil Testings & Research Administration

TESTANA ENGINEERING, INC.
Soil Testings & Research Administration

SR IMP-19/AK.07-07/2003.

LAPORAN PENYELIDIKAN TANAH

Proyek : Tower Mobile 8 Telecom.

Lokasi : Bangil, Jawa Timur.

Relasi : P.T. Imperium Mitra Persada, Surabaya.

DAFTAR ISI

LAMPIRAN

A.DC.1 s/d A.DC.2. Sondir.

A.BI. 1. Boring log.

A.DS.1 s/d A.DS.2. Direct shear test.

A.BC.1. Kapasitas dukung pondasi dangkal.

Surabaya, 16 Juli 2003

Testana Engineering, Inc.

Ir. Sugeng Setyawan, M.Sc.

Pimpinan

PENDAHULUAN.

ma Proyek	:	Tower Mobile 8 Telecom.
kasi	:	Bangil, Jawa Timur.
lasi	:	P.T. Imperium Mitra Persada, Surabaya.
juan penyelidikan	:	Mengevaluasi kekuatan dan kondisi tanah dasar setempat untuk menunjang perencanaan pondasi tower.
ngujian di lapangan	:	• 2 titik uji sondir (CPT), ASTM D-3441. • 1 titik bor-dangkal. • Undisturbed sampling, ASTM D-1587.
ngujian di laboratorium	:	• Uji kadar air alami (natural water content), ASTM D-2216. • Uji berat jenis, ASTM D-854. • Uji batas-batas konsistensi (Atterberg Limits), ASTM D-423 dan D-424. • Uji kuat geser, direct shear test, ASTM D-3080
sisi, elevasi & koordinat k-titik uji	:	Tidak dilakukan pengukuran topografi. Sketsa lapangan diberikan dalam Gambar 1.1. di bawah ini.

Gambar 1.1. Sketsa Lapangan

HASIL UJI LAPANGAN DAN LABORATORIUM

Hasil uji Lapangan.

Berdasarkan hasil-hasil uji lapangan, dapat disimpulkan bahwa hingga kedalaman ± -1.50 m uktur tanah tersusun atas lanau dan lempung berpasir berkonsistensi sangat lunak hingga sedang, ng dilanjutkan dengan campuran pasir dan lanau berkepadatan sedang s/d kedalaman -3.4 m/ -4 m. bawah lapisan ini dijumpai kembali lanau dan lempung dengan konsistensi sangat lunak s/d lunak gga kedalaman –6 m. Lapisan pasir dijumpai dibawah -6 m, kedapatan hingga tercapainya pasitas alat 250 kg/cm^2 pada kedalaman maksimum –7.4 m. Muka air tanah dilihat dari pemboran ngkal, dijumpai pada kedalaman –0.25 m. Pemboran dangkal hanya maksimal dapat dilakukan gga –2.50 m karena keberadaan lapisan pasir dan lanau yang senatiasa longsor saat dilakukan m..an, sehingga pemboran kedalaman berikutnya tertahan.

Hasil uji Laboratorium

Uji sifat-sifat fisis dan mekanis tanah dilakukan terhadap contoh terpilih yang terambil pada dalaman -1.00 m dan -2.00 m. Pengujian pada contoh tanah terambil meliputi uji kadar air, specific vity dan kuat geser tanah. Ringkasan hasil pengujian di laboratorium diberikan dalam tabel di wah ini :

bel 2.1. Hasil uji laboratorium.

or #	Depth, m	Classf.	c, kg/cm^2	φ°	γt, t/m^3	LL, %	PL, %	Gs	wc, %
D-01	1.00-1.50	MH	0.15	21	1.67	54	33	2.55	51
	2.00-2.50	MH	0.08	29	1.72	51	32	2.61	47

KAPASITAS DUKUNG PONDASI.

Pondasi tiang.

Melihat lapisan pendukung yang kokoh dan stabil dijumpai tak terlalu jauh dari muka tanah, mping pertimbangan akan stabilitas tower terhadap beban-beban lateral (angin) akan lebih aransi, maka sebagai salah satu pilihan yang mungkin dilaksanakan adalah pondasi tiang pracetak i yang dipancang dengan rig-rig semi manual dengan dropped hammer. Kapasitas dukung ijinnya ngkan berdasarkan data S-2 menurut metode *Bustamante-Gianeselli*, dan kedalaman tiang ari permukaan tanah saat pengujian. Panjang tiang perlu dikoreksi, bilamana terjadi n level muka tanah, misalnya oleh pengurugan/ penggalian. Output perhitungan dipaparkan bel 3.1, sbb.

. Kapasitas dukung pondasi tiang

ondasi	Dimensi cm	Kedalaman m	Q ujung, Ton	Q gesek, ton	Q ult, ton/tiang	Q all tekan, SF =3 ton/tiang	Q all tarik SF =4 ton/tiang
ancang	20x20	6	18	15	33	11	3.8

Pondasi tiang yang direncanakan dalam susunan kelompok (pile group) perlu memperhatikan tegangan tanah dibawah masing-masing ujung tiang yang cenderung saling bertumpukan bing) bila terlalu berdekatan. Karenanya, untuk meminimkan pengaruh overlapping, jarak antar ogyanya direncanakan tidak kurang dari 3x diameter tiang.

ndasi dangkal.

Untuk memberikan gambaran kekuatan tanah permukaan, maka diikaji alternatif pondasi persegi dengan dasar pondasi lebar 2 m diletakkan pada *kedalaman −2 m dari muka tanah nboran*. Kapasitas dukung ijin yang diberikan untuk pembebanan normal diperhitungkan dengan seperti pada saat pengujian. Kapasitas dukung ijin yang diberikan mencapai *0.87 kg/cm²* gan diberikan dalam *lampiran A.BC.1*

Pilihan pondasi dangkal sebagai penopang beban tower harus ditanam cukup dalam dan an dan dengan dimensi yang cukup tebal. Hal ini bertujuan agar pondasi dangkal mempunyai ndiri yang cukup untuk dapat menahan geseran, tarikan, ataupun gulingan, terutama akibat eban lateral terhadap tower. Bilamana kestabilan memerlukan, maka ukuran pondasi dangkal iperbesar hingga mungkin menjadi semacam pondasi plat penuh yang mengalasi kaki-kaki

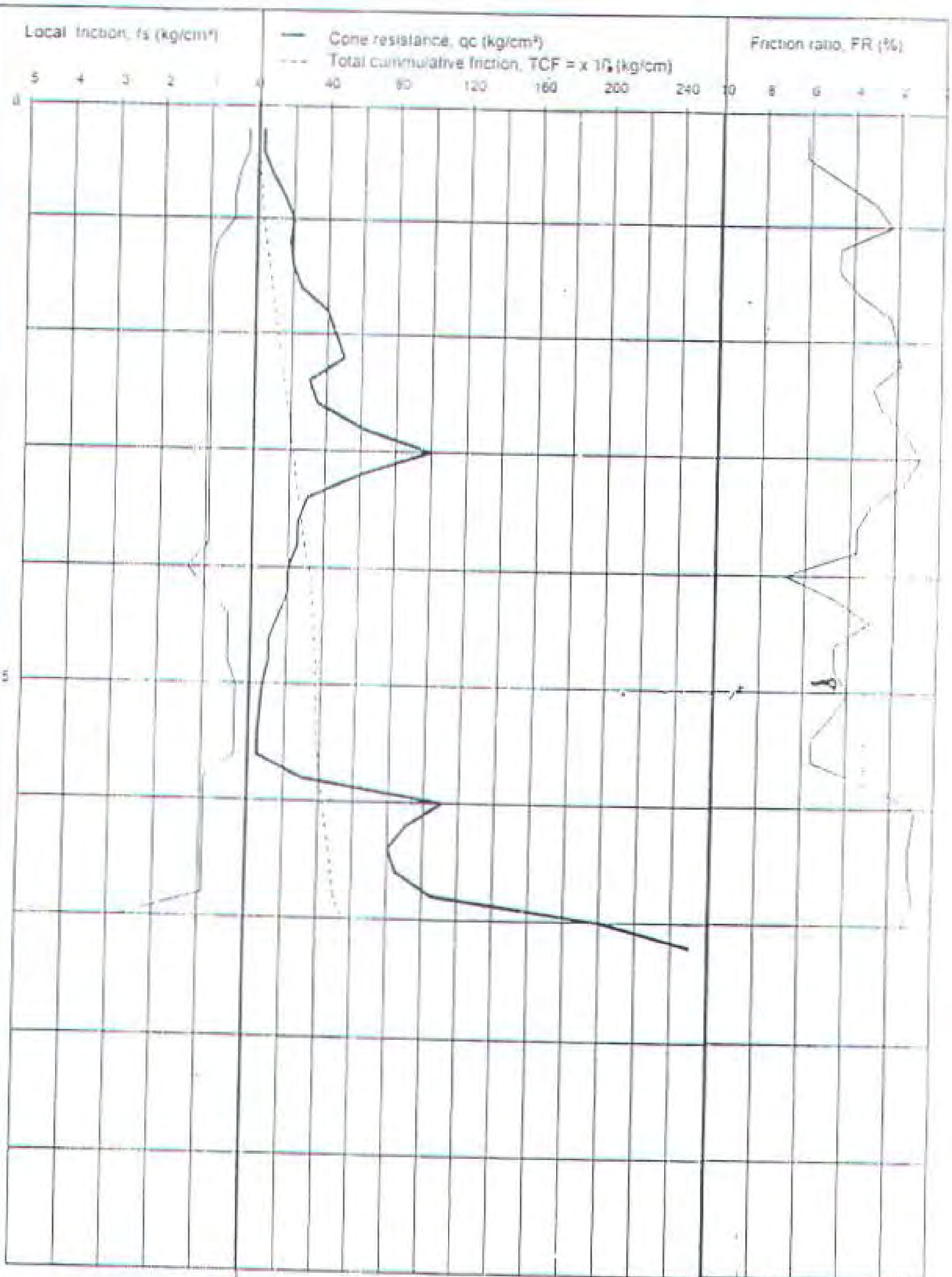
---------- *akhir laporan* ----------

TESTANA ENGINEERING, INC.
SURABAYA

LAMPIRAN

TESTANA ENGINEERING, INC.
Soil Testings & Research Administration

A.DC.1 DUTCH CONE PENETROMETER TEST (ASTM D-3441)



um depth	- 7.20	m	Project	Tower Mobile 8 Telecom	Sta/CH
Surface Level	± 0.00	m	Location	Bangil	Sounding No : S-1
Water Level	Unrecorded				Date of test : 10/07/2003

Testana Engineering, Inc.

Soil Testings & Research Administration

A.BL.1.

Tower Mobile 8 Telecom
Gangil

STA / CH -
BORING DEPTH - 2,50 m.

Ground Water Level -0,25 m
Ground Surface Level ± 0,00 m

SOIL DESCRIPTION	STRENGTH TEST				ATTERBERG LIMITS	γ_t	Gs	eo	Sr	γ_d	
	TYPE	C	Ø	qu	0 20 40 60 80 100						
Silt and clay, greyish brown, some sand	QT	0,15	21	-	33 51 54	1,67	2,55	1,31	100	1,11	57
Silt and sand, greyish brown, little clay	QT	0,08	29	-	32 47 51	1,72	2,61	1,23	100	1,17	[illegible]
Boring terminated											

0 % = Trace
0 % = Little
5 % = Some
0 % = And

C = Cohesion, kg/cm²
Ø = Angle of internal friction
UU = Unconsolidated undrained
CU = Consolidated undrained
CD = Consolidated drained
qu = Unconfined compression strength, kg/cm²

○ = Water content, %
● = Plastic limit, %
△ = Liquid limit, %

γ_t = Natural Density, gr/cm³
Gs = Specific Gravity
eo = Void Ratio
Sr = Degree of Saturation, %
γ_d = Dry Density, gr/cm³
n = Porosity, %

A.BC.1. BEARING CAPACITY OF FOOTING

Metode Terzaghi

t Tower Mobile 8 Telecom
on Bangil Jawa Timur

data BD-01

2 m
2 m
2 m

= 0.08 kg/cm² Nc' = 18
= 800 kg/m² Nq' = 7,5
= 29 Nγ' = 4.75
= 1.72 t/m³

= 2/3 x cu = 533 kg/m²
= (γ sat 1) x D, = 1440 kg/m²

= 1.3 x cu' x Nc' + q x Nq' + 0,4 x γ x B x Nγ'
= 1.3 x 533 x 18 + 1440 x 7,5 + 0,4 x 720 x 2 x 4.75
= 26 016 kg/m²
= 2.60 kg/cm²

= Qu / 3 = 2.60 / 3 = 0.87 kg/cm²

Elevasi	d/b	q/q0	q
-2.00	[illegible]	1.000	0.867
-3.00	[illegible]	0.673	0.583
-4.00	[illegible]	0.350	0.304
-5.00	[illegible]	0.186	0.161
-6.00	[illegible]	0.121	0.105

s terkonsolidasi -4.00 s/d -6.00 m, H= 2,00 m
x H = 36.68 kg/cm

= 0.18 kg/cm²

rata-rata lapis terkonsolidasi = 10 kg/cm²

= [(H x delta q) / (2.3 x qc rata-rata)] x 1
= 1.60 cm

TABLE 16-I—SEISMIC ZONE FACTOR Z

ZONE	1	2A	2B	3	4
Z	0.075	0.15	0.20	0.30	0.40

TE: The zone shall be determined from the seismic zone map in Figure 16-2.

TABLE 16-J—SOIL PROFILE TYPES

SOIL PROFILE TYPE	SOIL PROFILE NAME/GENERIC DESCRIPTION	AVERAGE SOIL PROPERTIES FOR TOP 100 FEET (30 480 mm) OF SOIL PROFILE		
		Shear Wave Velocity, $\bar{v}_s$ feet/second (m/s)	Standard Penetration Test, $\bar{N}$ [or $\bar{N}_{CH}$ for cohesionless soil layers] (blows/foot)	Undrained Shear Strength, $\bar{s}_u$ psf (kPa)
S_A	Hard Rock	> 5,000 (1,500)	—	—
S_B	Rock	2,500 to 5,000 (760 to 1,500)		
S_C	Very Dense Soil and Soft Rock	1,200 to 2,500 (360 to 760)	> 50	> 2,000 (100)
S_D	Stiff Soil Profile	600 to 1,200 (180 to 360)	15 to 50	1,000 to 2,000 (50 to 100)
S_E[1]	Soft Soil Profile	< 600 (180)	< 15	< 1,000 (50)
S_F	Soil Requiring Site-specific Evaluation. See Section 1629.3.1.			

[1]Profile Type S_E also includes any soil profile with more than 10 feet (3048 mm) of soft clay defined as a soil with a plasticity index, $PI > 20$, $w_{mc} \geq 40$ percent and $s_u < 500$ psf (24 kPa). The Plasticity Index, PI, and the moisture content, w_{mc}, shall be determined in accordance with approved national standards.

TABLE 16-K—OCCUPANCY CATEGORY

OCCUPANCY CATEGORY	OCCUPANCY OR FUNCTIONS OF STRUCTURE	SEISMIC IMPORTANCE FACTOR, I	SEISMIC IMPORTANCE[1] FACTOR, I_p	WIND IMPORTANCE FACTOR, I_w
1. Essential facilities[2]	Group I, Division 1 Occupancies having surgery and emergency treatment areas Fire and police stations Garages and shelters for emergency vehicles and emergency aircraft Structures and shelters in emergency-preparedness centers Aviation control towers Structures and equipment in government communication centers and other facilities required for emergency response Standby power-generating equipment for Category 1 facilities Tanks or other structures containing housing or supporting water or other fire-suppression material or equipment required for the protection of Category 1, 2 or 3 structures	1.25	1.50	1.15
2. Hazardous facilities	Group H, Divisions 1, 2, 6 and 7 Occupancies and structures therein housing or supporting toxic or explosive chemicals or substances Nonbuilding structures housing, supporting or containing quantities of toxic or explosive substances that, if contained within a building, would cause that building to be classified as a Group H, Division 1, 2 or 7 Occupancy	1.25	1.50	1.15
3. Special occupancy structures[3]	Group A, Divisions 1, 2 and 2.1 Occupancies Buildings housing Group E, Divisions 1 and 3 Occupancies with a capacity greater than 300 students Buildings housing Group B Occupancies used for college or adult education with a capacity greater than 500 students Group I, Divisions 1 and 2 Occupancies with 50 or more resident incapacitated patients, but not included in Category 1 Group I, Division 3 Occupancies All structures with an occupancy greater than 5,000 persons Structures and equipment in power-generating stations, and other public utility facilities not included in Category 1 or Category 2 above, and required for continued operation	1.00	1.00	1.00
4. Standard occupancy structures[3]	All structures housing occupancies or having functions not listed in Category 1, 2 or 3 and Group U Occupancy towers	1.00	1.00	1.00
5. Miscellaneous structures	Group U Occupancies except for towers	1.00	1.00	1.00

[1]The limitation of I_p for panel connections in Section 1633.2.4 shall be 1.0 for the entire connector.
[2]Structural observation requirements are given in Section 1702.
[3]For anchorage of machinery and equipment required for life-safety systems, the value of I_p shall be taken as 1.5.

FOOTNOTES TO TABLE 16-O—(Continued)

[12]Seismic restraints may be omitted from electrical raceways, such as cable trays, conduit and bus ducts, if all the following conditions are satisfied:

[12.1]Lateral motion of the raceway will not cause damaging impact with other systems.

[12.2]Lateral motion of the raceway does not cause loss of system vertical support.

[12.3]Rod-hung supports of less than 12 inches (305 mm) in length have top connections that cannot develop moments.

[12.4]Support members cantilevered up from the floor are checked for stability.

[13]Piping, ducts and electrical raceways, which must be functional following an earthquake, spanning between different buildings or structural systems shall be sufficiently flexible to withstand relative motion of support points assuming out-of-phase motions.

[14]Vibration isolators supporting equipment shall be designed for lateral loads or restrained from displacing laterally by other means. Restraint shall also be provided, which limits vertical displacement, such that lateral restraints do not become disengaged. a_p and R_p for equipment supported on vibration isolators shall be taken as 2.5 and 1.5, respectively, except that if the isolation mounting frame is supported by shallow or expansion anchors, the design forces for the anchors calculated by Formula (32-1), (32-2) or (32-3) shall be additionally multiplied by a factor of 2.0.

[15]Equipment anchorage shall not be designed such that lateral loads are resisted by gravity friction (e.g., friction clips).

[16]Expansion anchors, which are required to resist seismic loads in tension, shall not be used where operational vibrating loads are present.

[17]Movement of components within electrical cabinets, rack- and skid-mounted equipment and portions of skid-mounted electromechanical equipment that may cause damage to other components by displacing, shall be restricted by attachment to anchored equipment or support frames.

[18]Batteries on racks shall be restrained against movement in all directions due to earthquake forces.

[19]Seismic restraints may include straps, chains, bolts, barriers or other mechanisms that prevent sliding, falling and breach of containment of flammable and toxic materials. Friction forces may not be used to resist lateral loads in these restraints unless positive uplift restraint is provided which ensures that the friction forces act continuously.

TABLE 16-P—R AND Ω_o FACTORS FOR NONBUILDING STRUCTURES

STRUCTURE TYPE	R	Ω_o
1. Vessels, including tanks and pressurized spheres, on braced or unbraced legs.	2.2	2.0
2. Cast-in-place concrete silos and chimneys having walls continuous to the foundations.	3.6	2.0
3. Distributed mass cantilever structures such as stacks, chimneys, silos and skirt-supported vertical vessels.	2.9	2.0
4. Trussed towers (freestanding or guyed), guyed stacks and chimneys.	2.9	2.0
5. Cantilevered column-type structures.	2.2	2.0
6. Cooling towers.	3.6	2.0
7. Bins and hoppers on braced or unbraced legs.	2.9	2.0
8. Storage racks.	3.6	2.0
9. Signs and billboards.	3.6	2.0
10. Amusement structures and monuments.	2.2	2.0
11. All other self-supporting structures not otherwise covered.	2.9	2.0

TABLE 16-Q—SEISMIC COEFFICIENT C_a

SOIL PROFILE TYPE	SEISMIC ZONE FACTOR, Z				
	$Z = 0.075$	$Z = 0.15$	$Z = 0.2$	$Z = 0.3$	$Z = 0.4$
S_A	0.06	0.12	0.16	0.24	$0.32N_a$
S_B	0.08	0.15	0.20	0.30	$0.40N_a$
S_C	0.09	0.18	0.24	0.33	$0.40N_a$
S_D	0.12	0.22	0.28	0.36	$0.44N_a$
S_E	0.19	0.30	0.34	0.36	$0.36N_a$
S_F	See Footnote 1				

[1]Site-specific geotechnical investigation and dynamic site response analysis shall be performed to determine seismic coefficients for Soil Profile Type S_F.

TABLE 16-R—SEISMIC COEFFICIENT C_v

SOIL PROFILE TYPE	SEISMIC ZONE FACTOR, Z				
	Z = 0.075	Z = 0.15	Z = 0.2	Z = 0.3	Z = 0.4
S_A	0.06	0.12	0.16	0.24	$0.32N_v$
S_B	0.08	0.15	0.20	0.30	$0.40N_v$
S_C	0.13	0.25	0.32	0.45	$0.56N_v$
S_D	0.18	0.32	0.40	0.54	$0.64N_v$
S_E	0.26	0.50	0.64	0.84	$0.96N_v$
S_F	See Footnote 1				

[1]Site-specific geotechnical investigation and dynamic site response analysis shall be performed to determine seismic coefficients for Soil Profile Type S_F.

TABLE 16-S—NEAR-SOURCE FACTOR N_a[1]

SEISMIC SOURCE TYPE	CLOSEST DISTANCE TO KNOWN SEISMIC SOURCE[2,3]		
	≤ 2 km	5 km	≥ 10 km
A	1.5	1.2	1.0
B	1.3	1.0	1.0
C	1.0	1.0	1.0

[1]The Near-Source Factor may be based on the linear interpolation of values for distances other than those shown in the table.

[2]The location and type of seismic sources to be used for design shall be established based on approved geotechnical data (e.g., most recent mapping of active faults by the United States Geological Survey or the California Division of Mines and Geology).

[3]The closest distance to seismic source shall be taken as the minimum distance between the site and the area described by the vertical projection of the source on the surface (i.e., surface projection of fault plane). The surface projection need not include portions of the source at depths of 10 km or greater. The largest value of the Near-Source Factor considering all sources shall be used for design.

TABLE 16-T—NEAR-SOURCE FACTOR N_v[1]

SEISMIC SOURCE TYPE	CLOSEST DISTANCE TO KNOWN SEISMIC SOURCE[2,3]			
	≤ 2 km	5 km	10 km	≥ 15 km
A	2.0	1.6	1.2	1.0
B	1.6	1.2	1.0	1.0
C	1.0	1.0	1.0	1.0

[1]The Near-Source Factor may be based on the linear interpolation of values for distances other than those shown in the table.

[2]The location and type of seismic sources to be used for design shall be established based on approved geotechnical data (e.g., most recent mapping of active faults by the United States Geological Survey or the California Division of Mines and Geology).

[3]The closest distance to seismic source shall be taken as the minimum distance between the site and the area described by the vertical projection of the source on the surface (i.e., surface projection of fault plane). The surface projection need not include portions of the source at depths of 10 km or greater. The largest value of the Near-Source Factor considering all sources shall be used for design.

TABLE 16-U—SEISMIC SOURCE TYPE[1]

SEISMIC SOURCE TYPE	SEISMIC SOURCE DESCRIPTION	SEISMIC SOURCE DEFINITION[2]	
		Maximum Moment Magnitude, M	Slip Rate, SR (mm/year)
A	Faults that are capable of producing large magnitude events and that have a high rate of seismic activity	$M \geq 7.0$	$SR \geq 5$
B	All faults other than Types A and C	$M \geq 7.0$ $M < 7.0$ $M \geq 6.5$	$SR < 5$ $SR > 2$ $SR < 2$
C	Faults that are not capable of producing large magnitude earthquakes and that have a relatively low rate of seismic activity	$M < 6.5$	$SR \leq 2$

[1]Subduction sources shall be evaluated on a site-specific basis.

[2]Both maximum moment magnitude and slip rate conditions must be satisfied concurrently when determining the seismic source type.

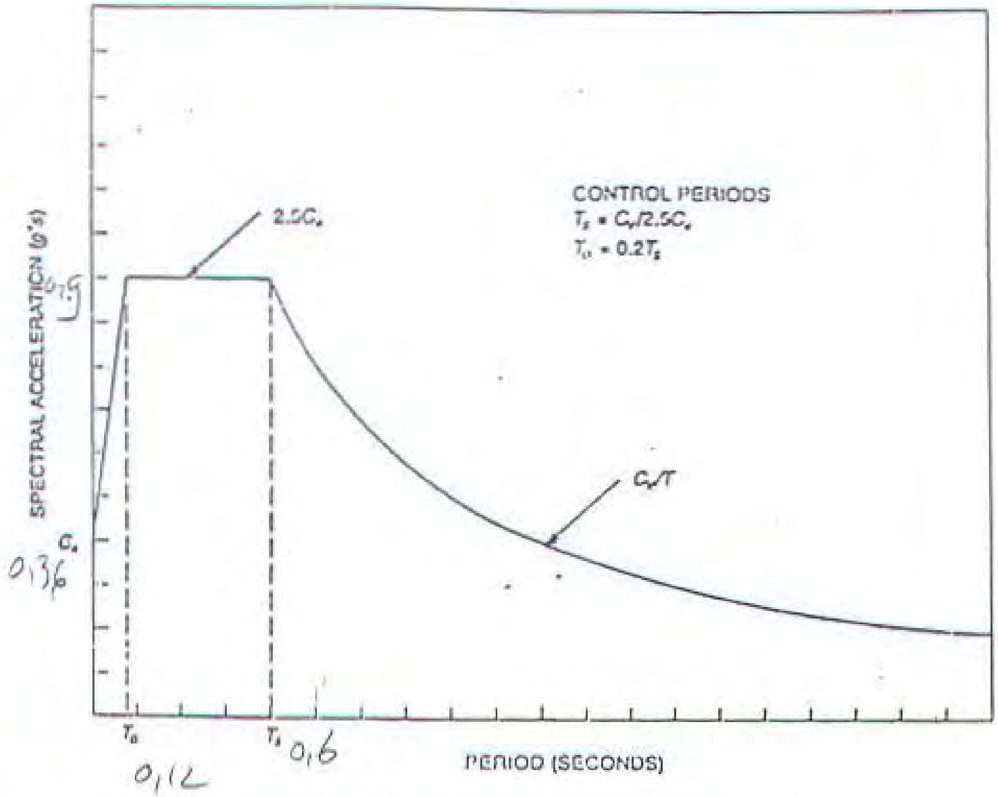


FIGURE 16-3—DESIGN RESPONSE SPECTRA

$C_a = 0{,}36$
$C_V = 0{,}54$

$T_S = \frac{C_V}{2{,}5\,C_a} = \frac{0{,}54}{(0{,}36 \times 2{,}5)} = 0{,}6$

$T_0 = 0{,}075 =$

Table 1					
Force Coefficients (C_F) for Cantilevered Tubular Pole Structures					
C nph ft)	Round	16 Sided $r < 0.26$	16 Sided $r \geq 0.26$	12 Sided	8 Sided
< 32	1.20	1.20	1.20	1.20	1.20
2 to 64	$\frac{130}{(C)^{1.3}}$	$1.78 + 1.40r - \frac{C}{91.5} - \frac{C(r)}{22.9}$	$72 + \frac{(64 - C)}{44.8}$	$\frac{12.5}{(C)^{.6}}$	1.20
> 64	.59	1.08 - 1.40r	72	1.03	1.20
SI Units					
C n/s m)	Round	16 Sided $r < 0.26$	16 Sided $r \geq 0.26$	12 Sided	8 Sided
: 4.4	1.20	1.20	1.20	1.20	1.20
to 8.7	$\frac{9.74}{(C)^{1.3}}$	$1.78 + 1.40r - \frac{C}{12.5} - \frac{C(r)}{3.12}$	$.72 + \frac{(8.7 - C)}{6.10}$	$\frac{3.78}{(C)^{.6}}$	1.20
· 8.7	.59	1.08 - 1.40r	.72	1.03	1.20

$\sqrt{K_Z}\ V\ D_P$ for D_P in ft [m]

es:

The above force coefficients apply only to cantilevered tubular pole structures which d alone or are mounted on the top of a latticed structure.

The force coefficients indicated account for wind load reductions under supercritical flow litions and therefore do not apply to appurtenances attached to the structure. Use Table 3 for opriate force coefficients for appurtenances.

For all cross sectional shapes, C_f need not exceed 1.2 for any value of C.

V is the basic wind speed for the loading condition under investigation.

Table 2						
Wind Direction Factors						
wer Cross Section	Square		Triangular			
Direction	Normal	±45°*	Normal	60°*	±90°*
D_F	1.0	1+.75e (1.2 max)	1.0	.80	.85
D_R	1.0	1+.75e (1.2 max)	1.0	1.0	1.0

sured from a line normal to the face of the structure

2.3.7 The force coefficient (C_A) applied to the projected area (ft^2) [m^2] of a linear appurtenance (A_A) not considered as a structural component shall be determined from Table 3. The force coefficient for cylindrical members may be applied to the additional projected area of radial ice when specified. (Refer to Figure 1.)

Table 3		
Appurtenance Force Coefficients		
	Aspect Ratio ≤ 7	Aspect Ratio ≥ 25
Member Type	C_A	C_A
Flat	1.4	2.0
Cylindrical	0.8	1.2

Aspect Ratio = Overall length/width ratio in plane normal to wind direction. (Aspect ratio is not a function of the spacing between support points of a linear appurtenance, nor the section length considered to have a uniformly distributed force.)

Note: Linear interpolation may be used for aspect ratios other than shown.

2.3.8 Regardless of location, linear appurtenances not considered as structural components in accordance with 2.3.6.3 shall be included in the term $\sum C_A A_A$.

2.3.9 The horizontal force (F) applied to a section of the structure may be assumed to be uniformly distributed based on the wind pressure at the mid-height of the section.

2.3.9.1 For guyed masts, the section considered to have a uniformly distributed force shall not exceed the span between guy levels.

2.3.9.2 For free-standing structures, the section considered to have a uniformly distributed force shall not exceed 60 ft [18 m].

2.3.9.3 For tubular steel pole structures, the section considered to have a uniformly distributed force shall not exceed 30 ft [9.1 m].

2.3.10 In the absence of more accurate data, the design wind load (F_C) on a discrete appurtenance such as an ice shield, platform, etc. (excluding microwave antennas/passive reflectors) shall be calculated from the equation:

$$F_C = q_Z G_H [\sum C_A A_C] \text{ (lb) [N]}$$

where $\sum C_A A_C$ considers all elements of the discrete appurtenance including any feed lines, brackets, etc., related to the appurtenance. Components of a discrete appurtenance attached directly to a tower face and not projecting away from the face may be considered as structural components when calculating the solidity ratio and wind forces.

2.3.10.1 The velocity pressure (q_Z) shall be calculated based on the centerline height of the appurtenance.

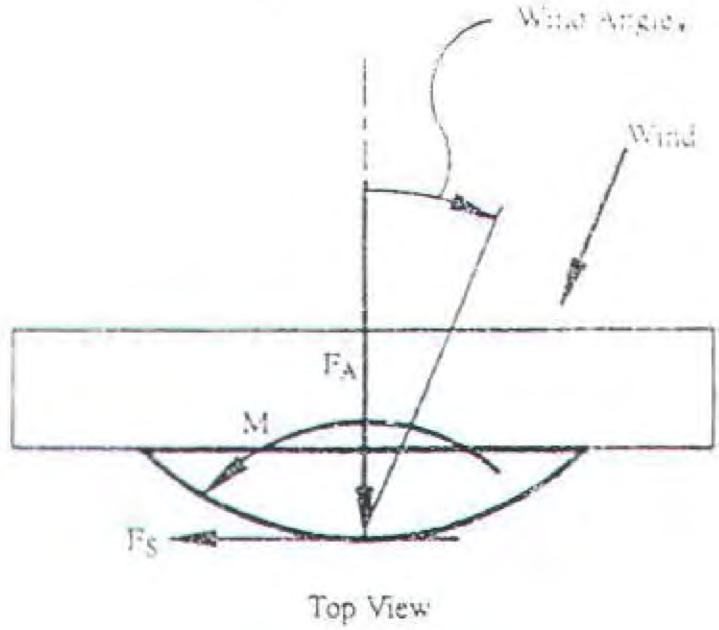
Table B.3 Wind Force Coefficients for Typical Paraboloid With Cylindrical Shroud

Solid dish

WIND ANGLE Θ (DEG)	C_A	C_S	C_M
0	.00323	.00000	.000000
10	.00323	.00025	-.000072
20	.00320	.00045	-.000116
30	.00310	.00060	-.000133
40	.00296	.00072	-.000125
50	.00278	.00078	-.000083
60	.00242	.00094	-.000022
70	.00172	.00122	.000058
80	.00070	.00149	.000178
90	-.00028	.00160	.000251
100	-.00088	.00154	.000288
110	-.00138	.00136	.000292
120	-.00182	.00112	.000266
130	-.00220	.00080	.000237
140	-.00239	.00059	.000199
150	-.00245	.00045	.000158
160	-.00249	.00038	.000112
170	-.00255	.00025	.000059
180	-.00260	.00000	.000000
190	-.00255	-.00025	-.000059
200	-.00249	-.00038	-.000112
210	-.00245	-.00045	-.000158
220	-.00239	-.00059	-.000199
230	-.00220	-.00080	-.000237
240	-.00182	-.00112	-.000266
250	-.00138	-.00136	-.000292
260	-.00088	-.00154	-.000288
270	-.00028	-.00160	-.000251
280	.00070	-.00149	-.000178
290	.00172	-.00122	-.000058
300	.00242	-.00094	.000022
310	.00278	-.00078	.000083
320	.00296	-.00072	.000125
330	.00310	-.00060	.000133
340	.00320	-.00045	.000116
350	.00323	-.00025	.000072

[illegible] Wind Force Coefficients for Typical Passive Reflector

WIND ANGLE Θ (DEG)	C_A	C_S	C_M
0	.00351	.00000	.000000
10	.00348	.00003	-.000077
20	.00341	.00008	.000134
30	.00329	.00010	.000180
40	.00309	.00013	.000198
50	.00300	.00018	.000208
60	.00282	.00021	-.000262
70	.00178	.00023	-.000225
80	.00071	.00027	-.000129
90	-.00010	.00030	.000030
100	.00108	.00035	.000180
110	.00235	.00039	.000225
120	-.00348	.00036	.000210
130	.00348	.00029	.000148
140	.00360	.00023	.000126
150	.00376	.00019	.000109
160	-.00390	.00012	.000080
170	-.00400	.00008	.000042
180	.00403	.00000	.000000
190	-.00400	-.00008	-.000042
200	-.00390	-.00012	-.000080
210	-.00376	-.00019	-.000109
220	-.00360	-.00023	-.000126
230	-.00348	-.00029	-.000148
240	.00348	-.00036	.000210
250	-.00235	-.00039	-.000225
260	.00108	-.00035	-.000180
270	-.00010	-.00030	-.000030
280	.00071	-.00027	.000129
290	.00178	-.00023	.000225
300	.00282	-.00021	.000262
310	.00300	-.00018	.000208
320	.00309	-.00013	.000198
330	.00329	-.00010	.000180
340	.00341	-.00008	.000134
350	.00348	.00003	.000077



Positive Sign Convention

Figure B3. Wind Forces on Paraboloids With Cylindrical Shrouds

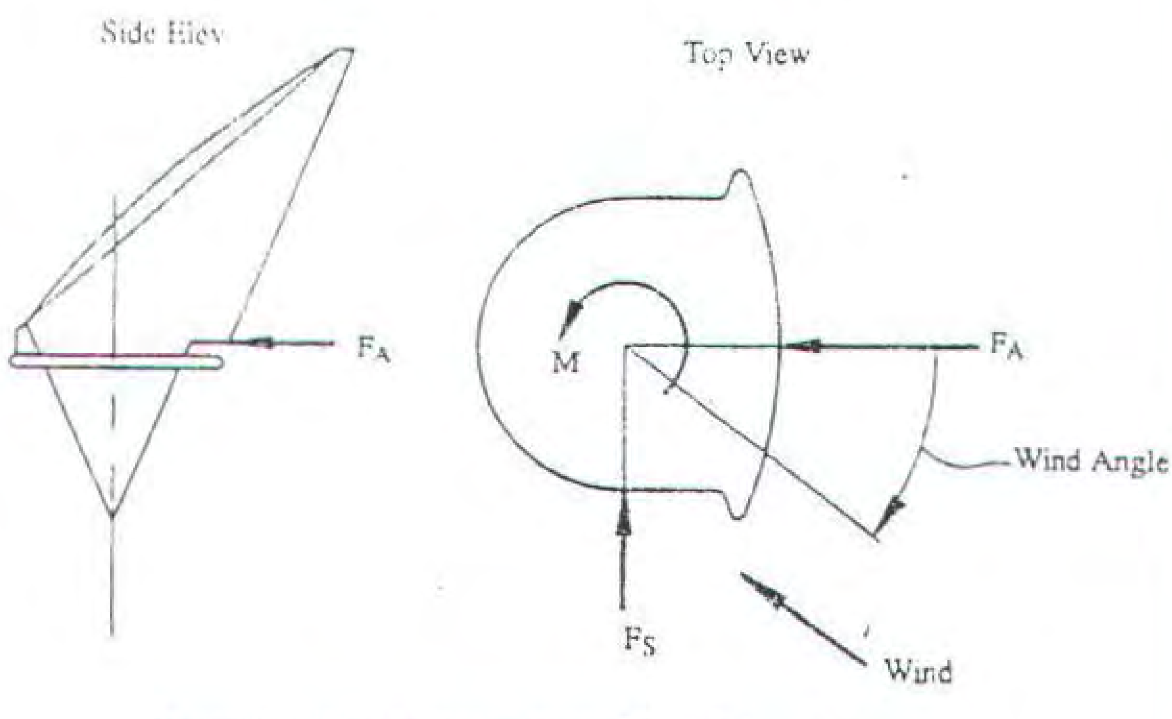
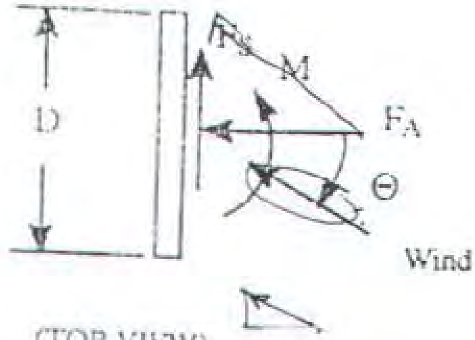


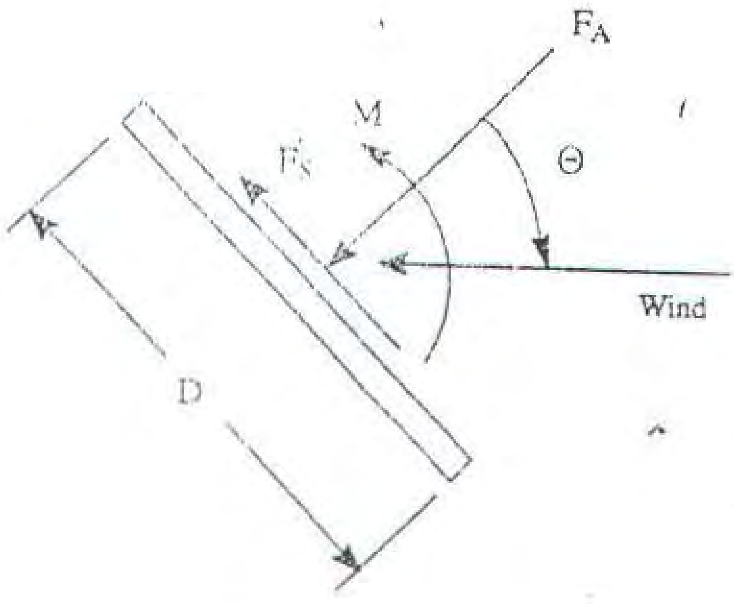
Figure B4. Wind Forces on Conical Horn Reflector Antennas



(TOP VIEW)

Θ = Horizontal Wind Angle
D = Width of Reflector

(A) PLATE VERTICAL



(SIDE VIEW)

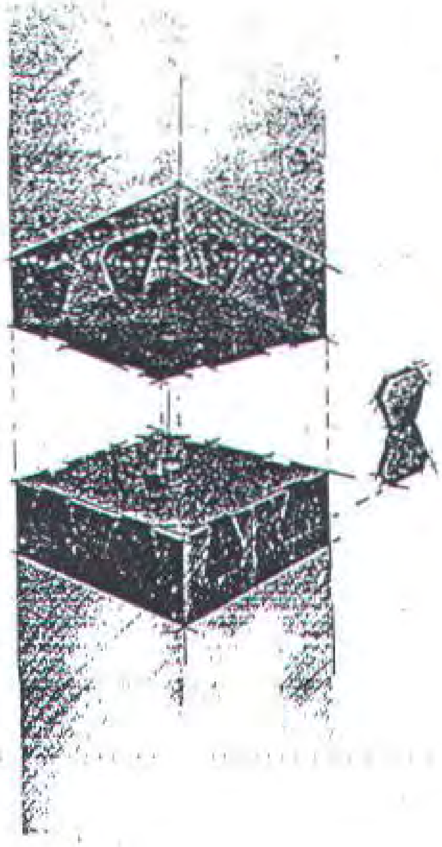
Θ = Vertical Plate Angle
D = Length of Reflector
(Horizontal Wind Angle = 0 or 180 Deg Only)

(B) PLATE TILTED

Figure B5. Wind Forces on Flat Plate Passive Reflectors

PRECAST PRESTRESSED CONCRETE SOLID SQUARE PILES STANDARD SPECIFICATION

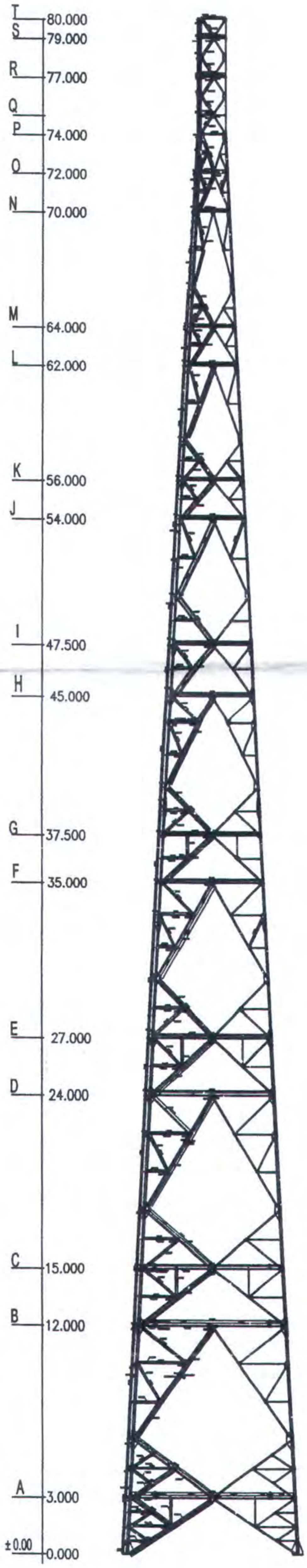
AREA	WEIGHT	NUMBER OF STRAND / LENGTH OF PILE - METER							STRUCTURAL STRENGTH	
(MM^2)	(KG/M^1)	UP TO 12	13 - 14 M	15 - 16 M	17 - 18 M	19 - 20 M	21 - 22 M	23 - 25 M	P Ult / KG	M Ult / KG M
40.000	96	4 ea 3/8"	4 ea 3/8"	—	—	—	—	—	59.160	3.060
62.500	150	4 ea 3/8"	4 ea 3/8"	5 ea 3/8"	6 ea 3/8"	4 ea 1/12"	—	—	94.600	4.810
90.000	215	4 ea 3/8"	5 ea 3/8"	6 ea 3/8"	4 ea 1/2"	5 ea 1/2"	6 ea 1/2"	—	138.190	8.320
122.500	295	4 ea 3/8"	5 ea 3/8"	4 ea 1/2"	5 ea 1/2"	6 ea 1/2"	7 ea 1/2"	9 ea 1/2"	186.790	12.130
160.000	384	4 ea 1/2"	5 ea 1/2"	5 ea 1/2"	6 ea 1/2"	7 ea 1/2"	8 ea 1/2"	10 ea 1/2"	245.620	16.840
202.500	486	5 ea 1/2"	5 ea 1/2"	6 ea 1/2"	7 ea 1/2"	J ea 1/2"	9 ea 1/2"	12 ea 1/2"	312.710	21.840
250.000	602	6 ea 1/2"	6 ea 1/2"	7 ea 1/2"	8 ea 1/2"	9 ea 1/2"	11 ea 1/2"	13 ea 1/2"	368.050	27.730



JHS WEDGE JOINT SYSTEM

Some of advantages :

- JHS wedge joint system is patented internationally
- The strength of joint depends on wedge and not to welding. The welding is only to keep the wedge in place
- The joint has equal stiffness to the pile itself, so it can avoid stress concentration in joint.



	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
S U R A B A Y A

	Name	Date	Sign
Designed			
Drawn			
Checked			
Approved			

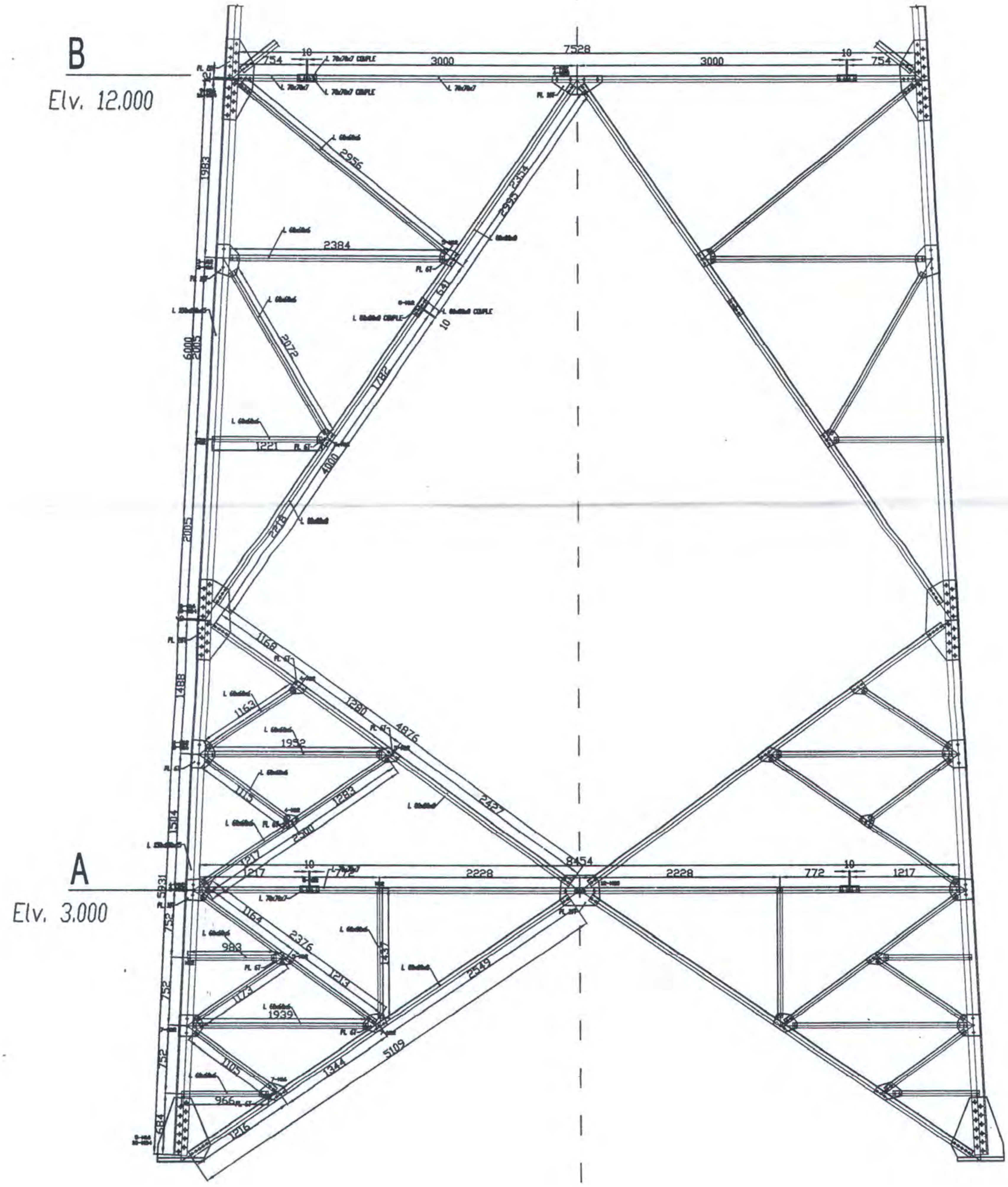
Title: TOWER SST-80 M

Sub Title: KEY PLAN

SCALA :NTS

Drawing No: 1

Index: 0

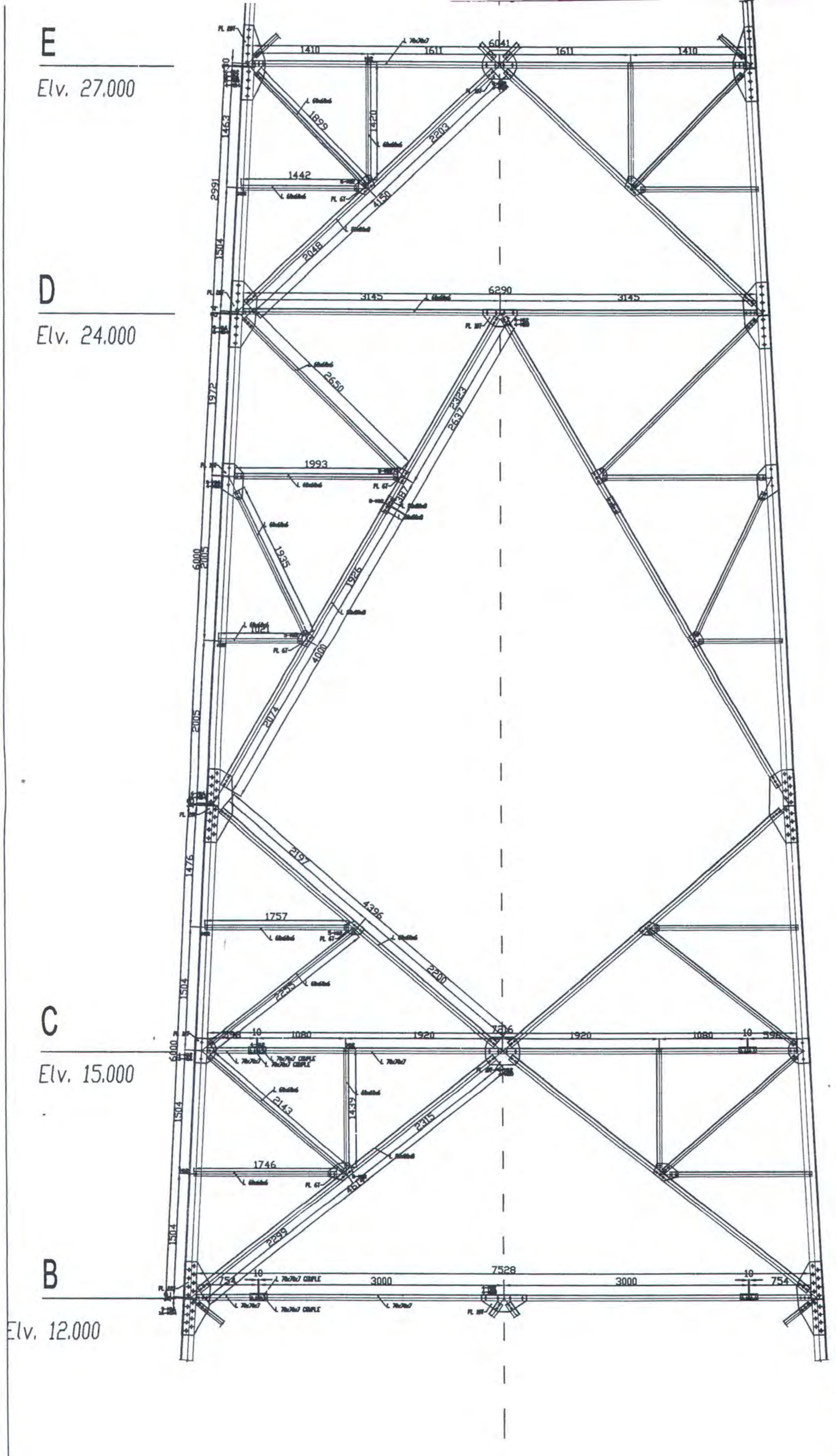


	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
S U R A B A Y A

	Name	Date	Sign	Title
Designed				TOWER SST-80 M
Drawn				Sub Title
Checked				BODY PART 1
Approved				

	Drawing No	Index
SCALA 1:50	2	0



	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
S U R A B A Y A

	Name	Date	Sign
Designed			
Drawn			
Checked			
Approved			

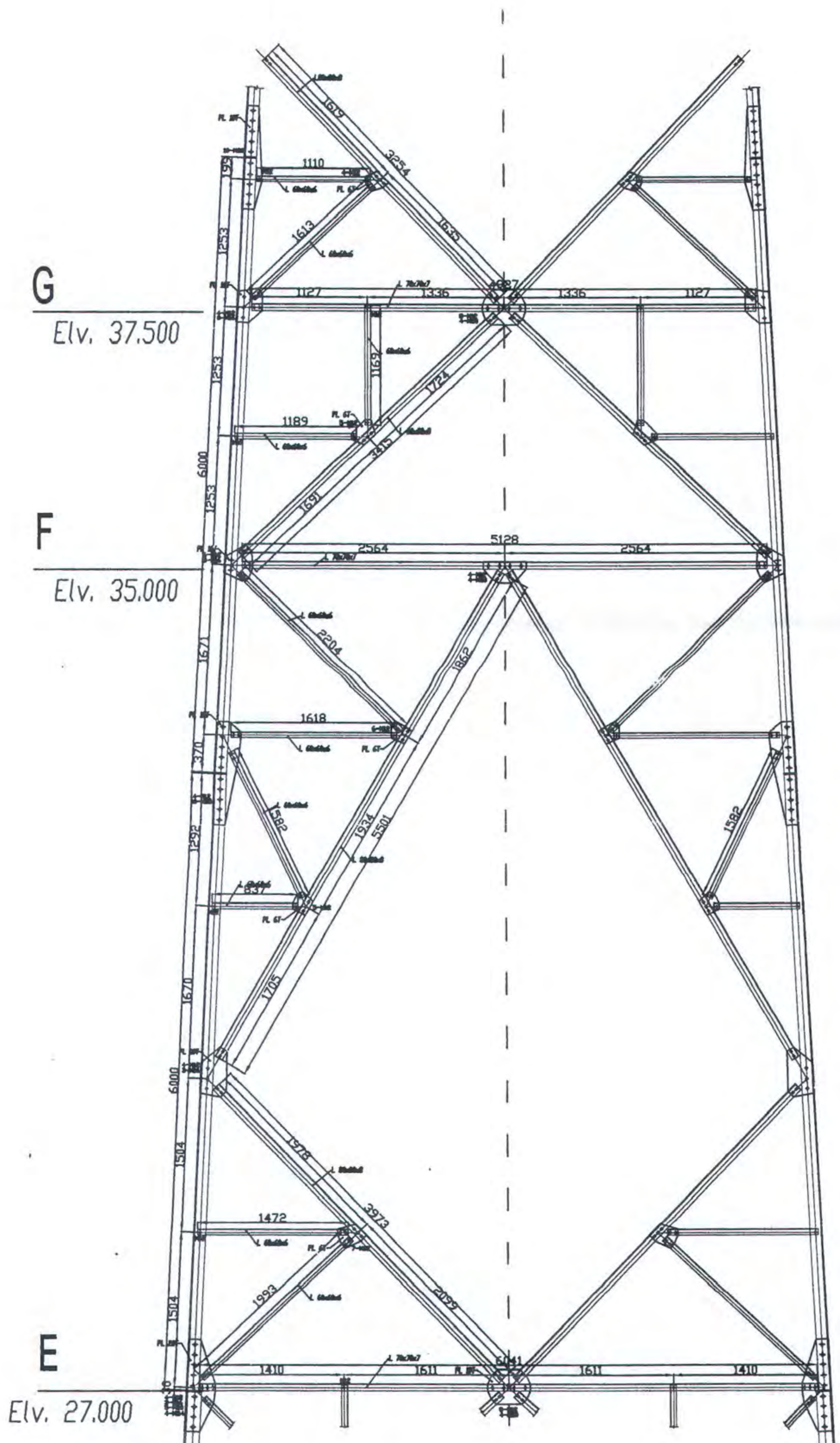
Title: TOWER SST-80 M

Sub Title: BODY PART 2

SCALA 1:50

Drawing No: 3

Index: 0



	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
S U R A B A Y A

	Name	Date	Sign
Designed			
Drawn			
Checked			
Approved			

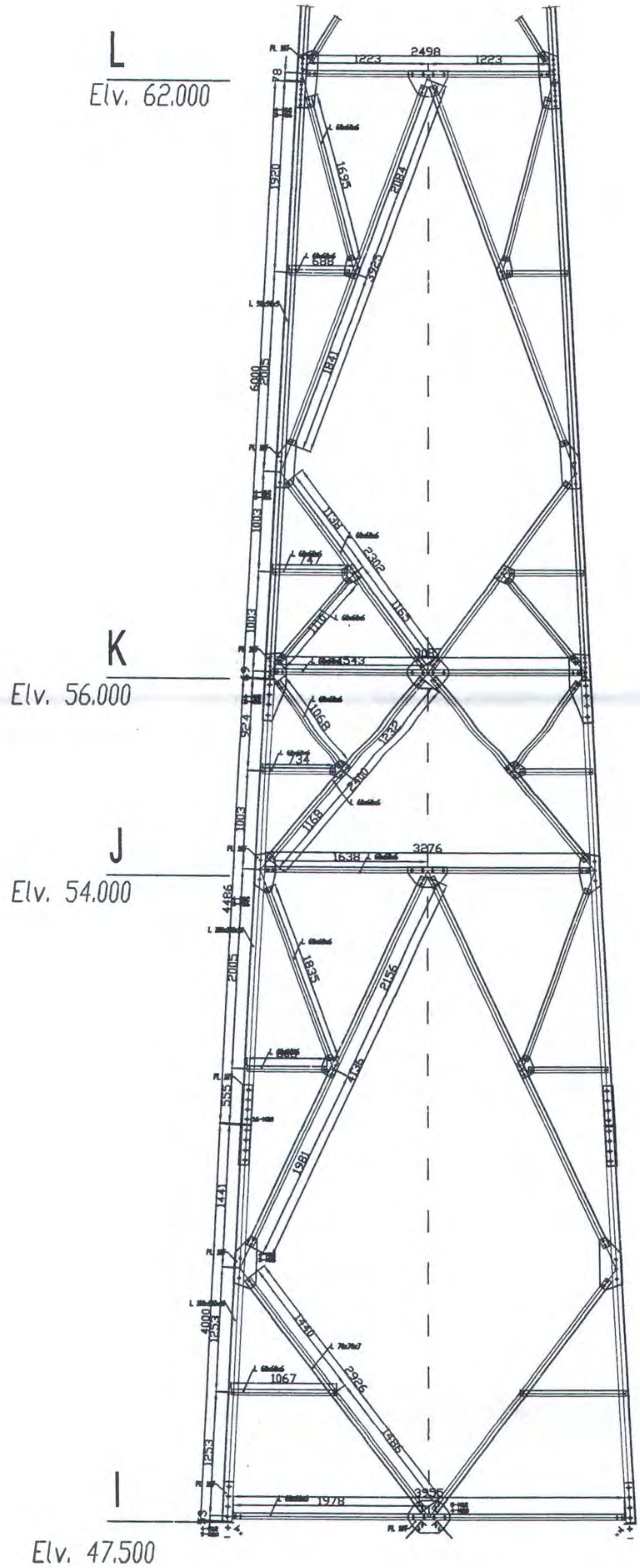
Title: TOWER SST-80 M

Sub Title: BODY PART E,F,G

SCALA 1:50

Drawing No: 4

Index: 0



	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA

	Name	Date	Sign
Designed			
Drawn			
Checked			
Approved			

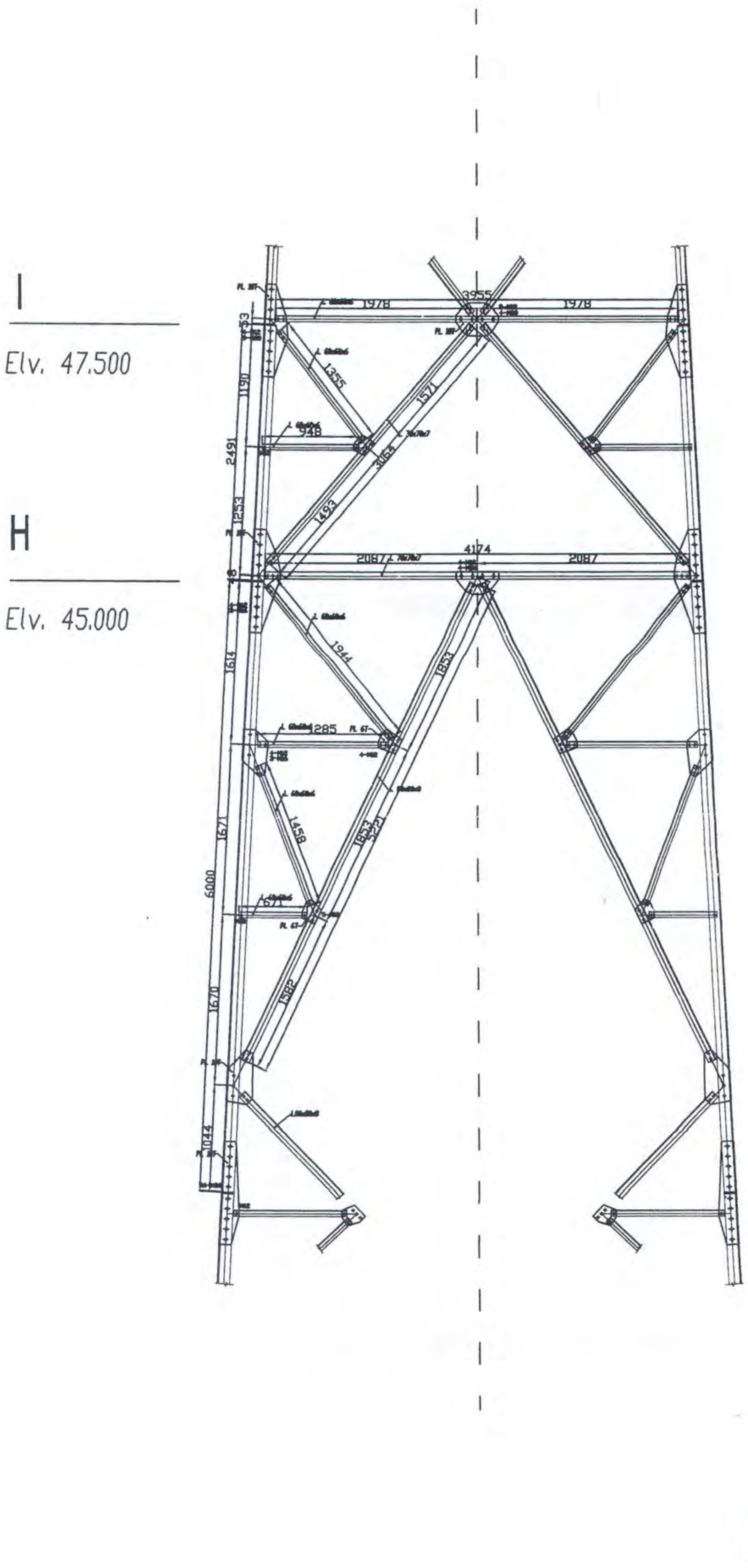
Title: TOWER SST-80 M

Sub Title: BODY PART J,K,L

SCALA 1:50

Drawing No: 6

Index: 0

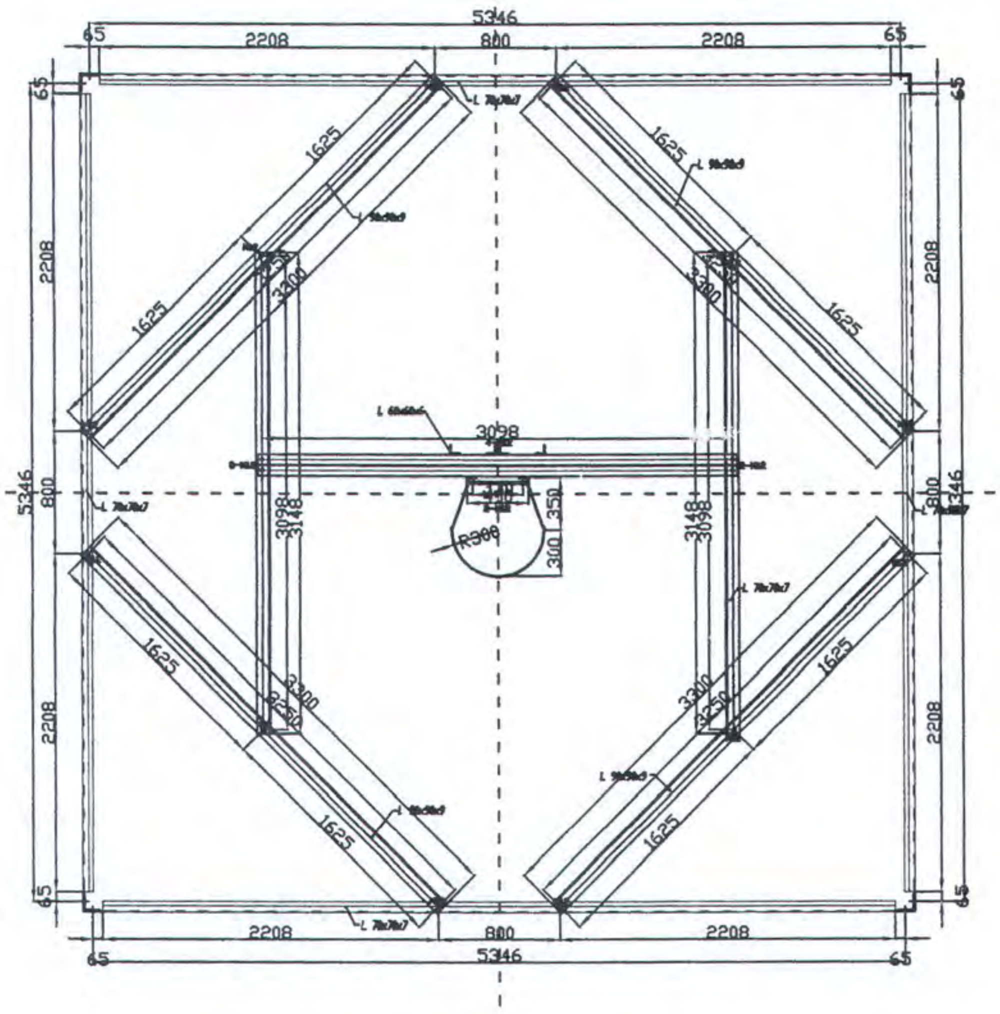


	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

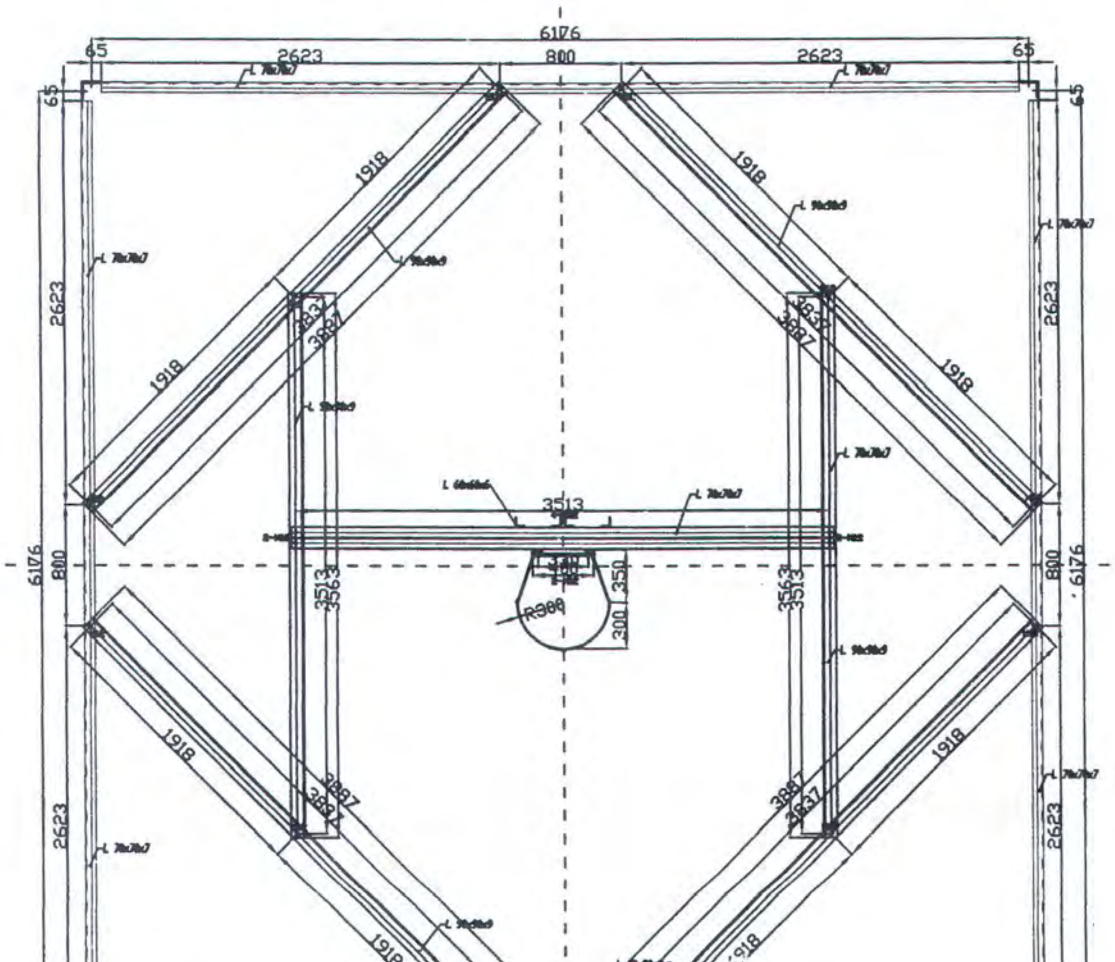
JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
S U R A B A Y A

	Name	Date	Sign	
Designed				Title: TOWER SST-80 M
Drawn				
Checked				Sub Title: BODY PART H,I
Approved				

SCALA 1:50	Drawing No: 5	Index: 0



PLATFORM E
Elv. 35.000



PLATFORM D
Elv. 27.000

	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

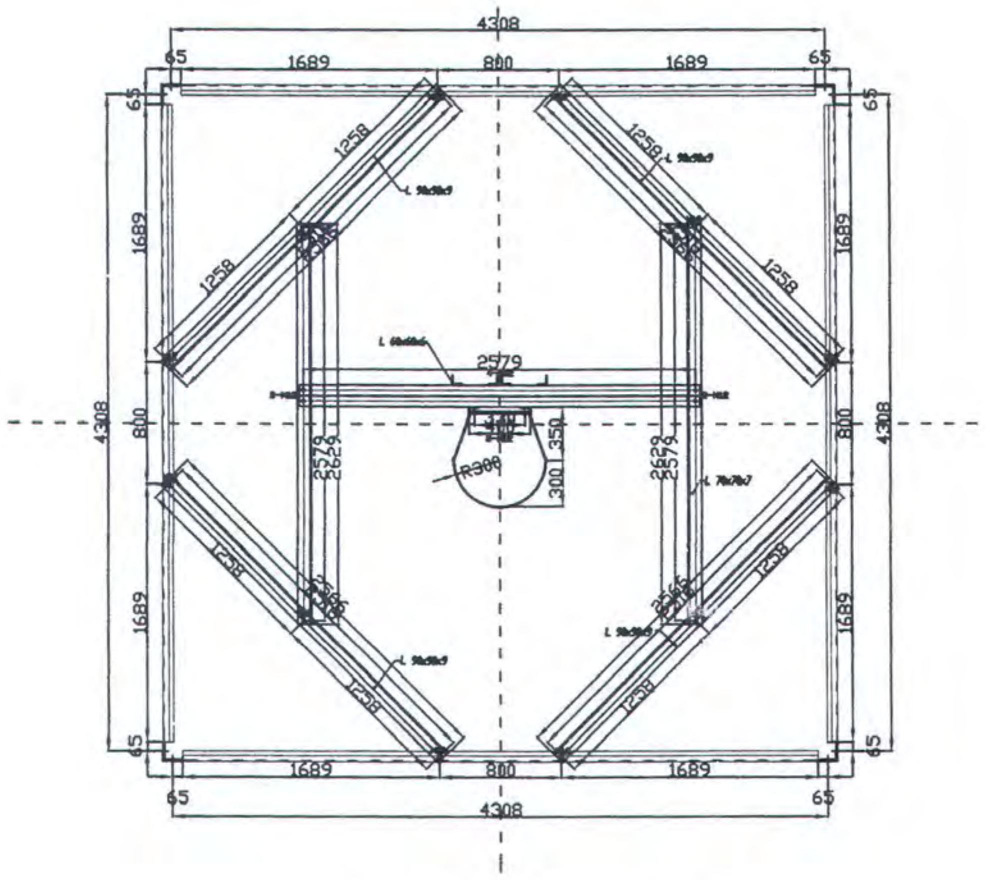
JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA

	Name	Date	Sign
Designed			
Drawn			
Checked			
Approved			

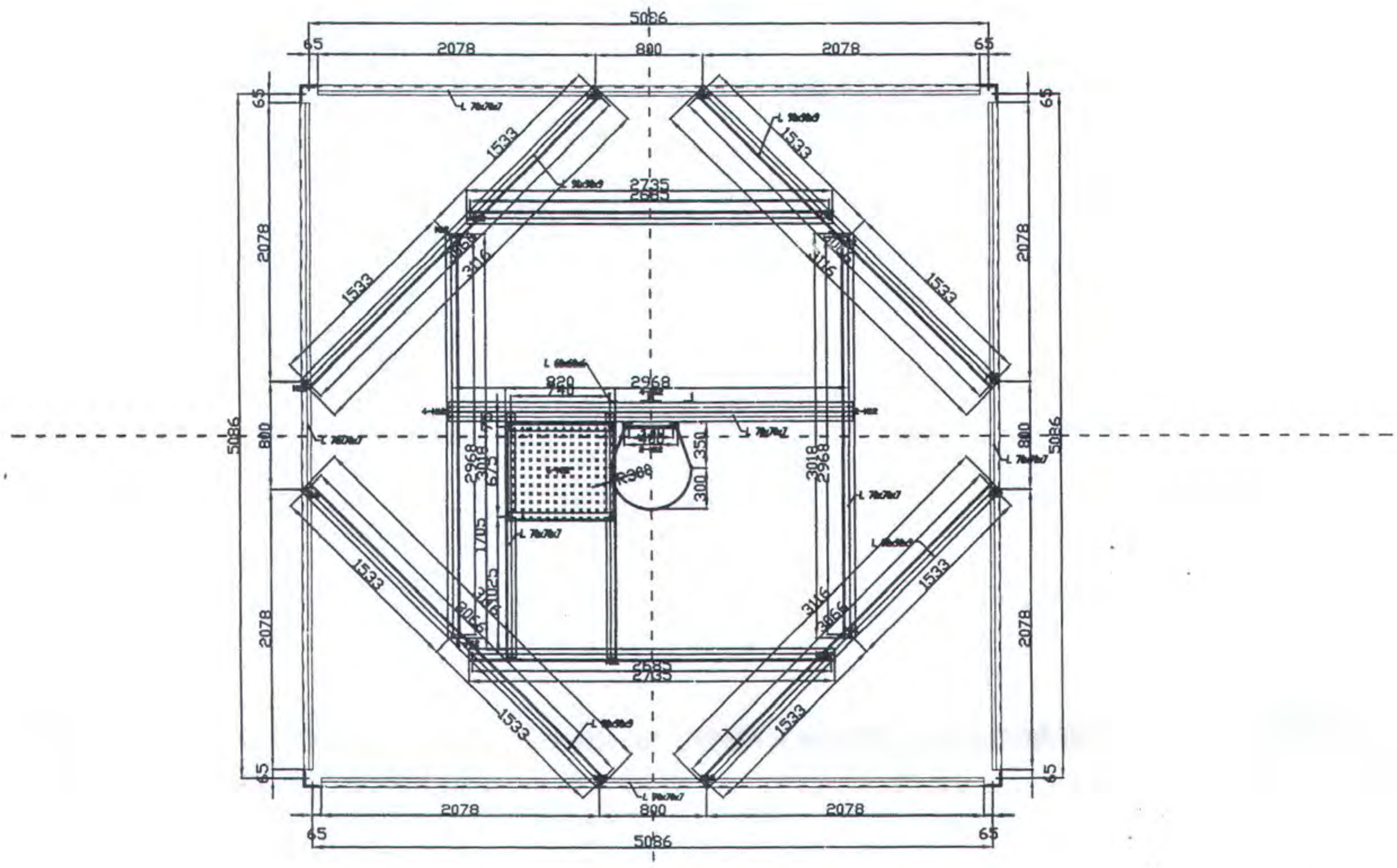
Title: TOWER SST-80 M

Sub Title: PLATFORM D,E

	Drawing No	Index
SCALA 1:50	11	0



PLATFORM G
Elv. 45.000



PLATFORM F
Elv. 37.500

	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA

	Name	Date	Sign
Designed			
Drawn			
Checked			
Approved			

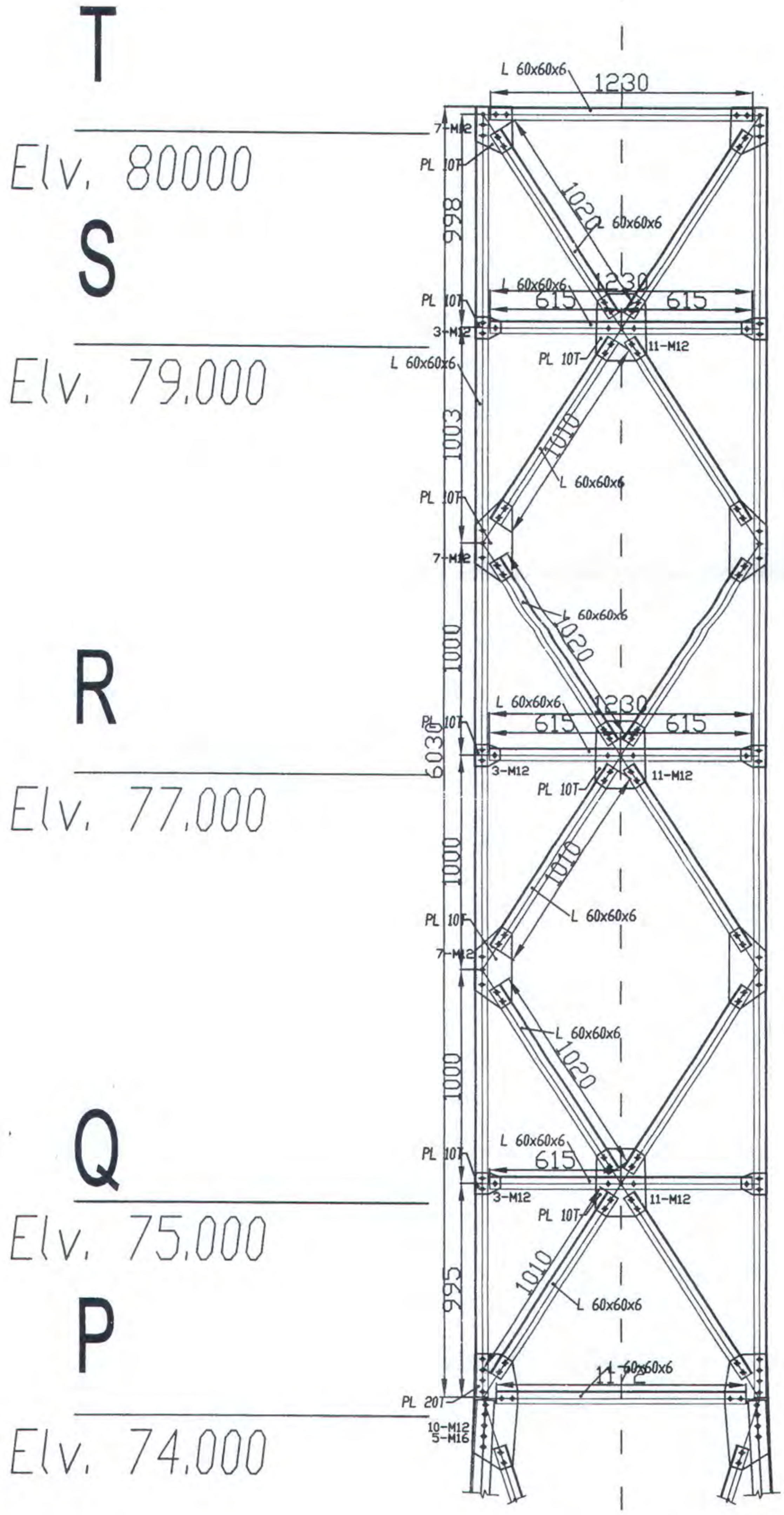
Title: TOWER SST-80 M

Sub Title: PLATFORM F,G

SCALA 1:50

Drawing No: 12

Index: 0

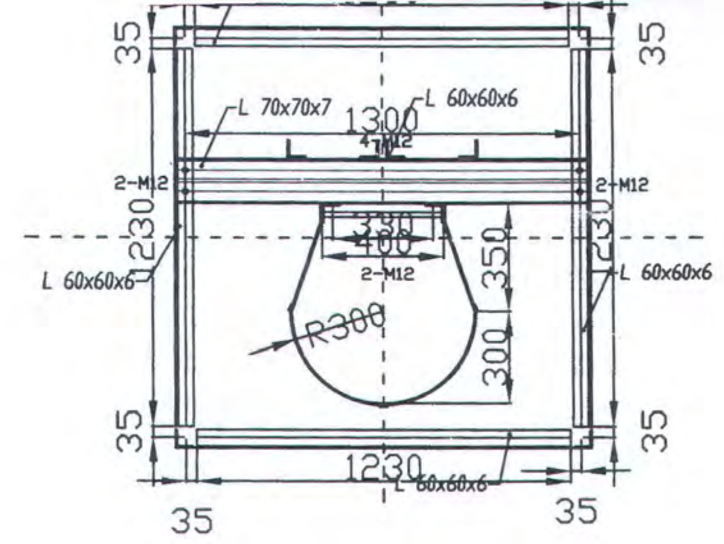


	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
S U R A B A Y A

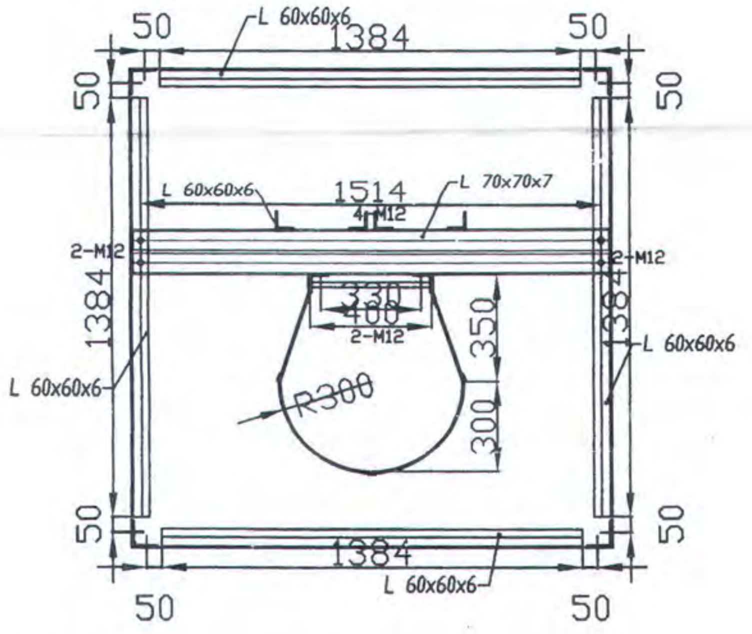
	Name	Date	Sign	
Designed				Title: TOWER SST-80 M.
Drawn				
Checked				Sub Title: BODY PART J,K,L
Approved				

	Drawing No	Index
SCALA 1:25	8	0



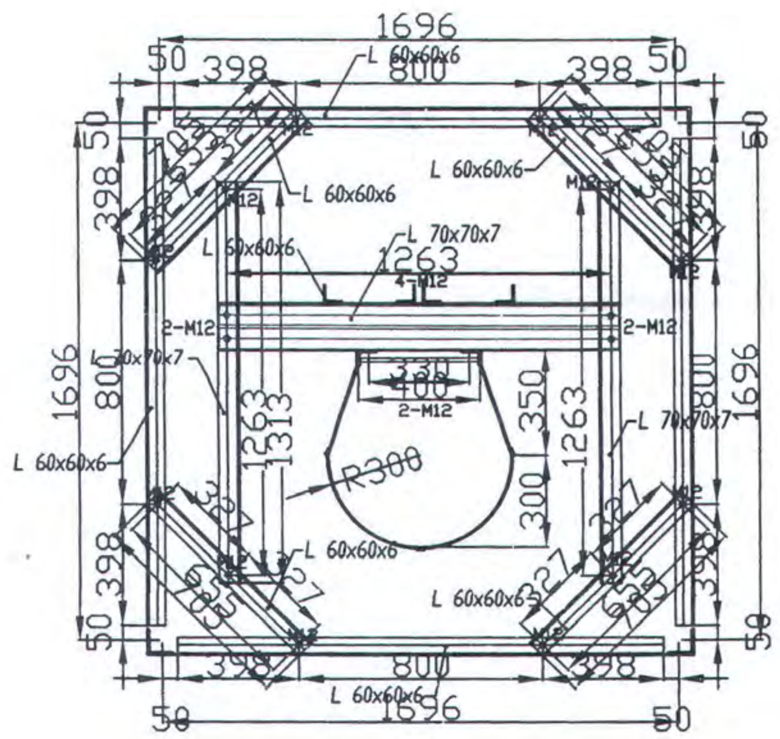
PLATFORM O, P, Q, R

Elv. 74.000;75.000;77.000;79.000;80.000



PLATFORM N

Elv. 72.000



PLATFORM M

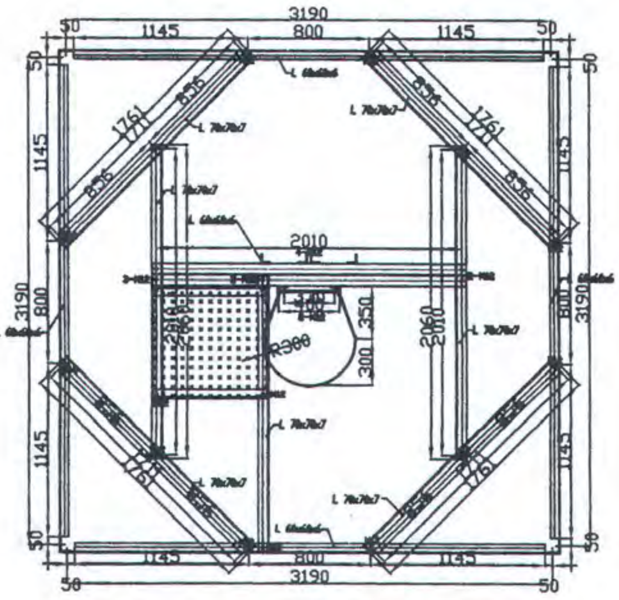
Elv. 70.000

	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

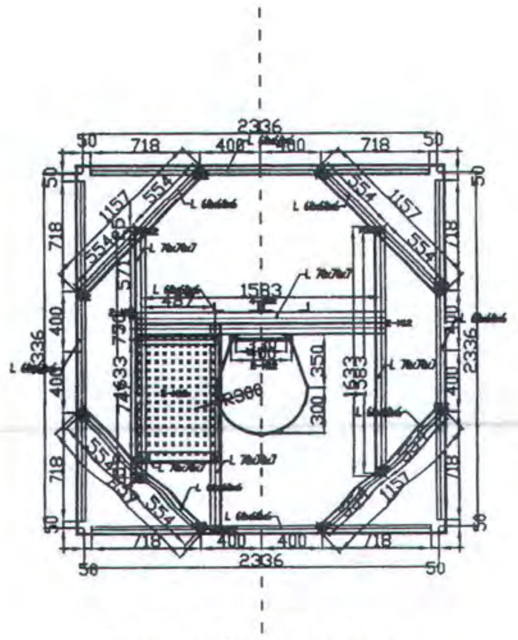
JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
S U R A B A Y A

	Name	Date	Sign	Title
Designed				TOWER SST-80 M
Drawn				Sub Title
Checked				PLATFORM H-S
Approved				

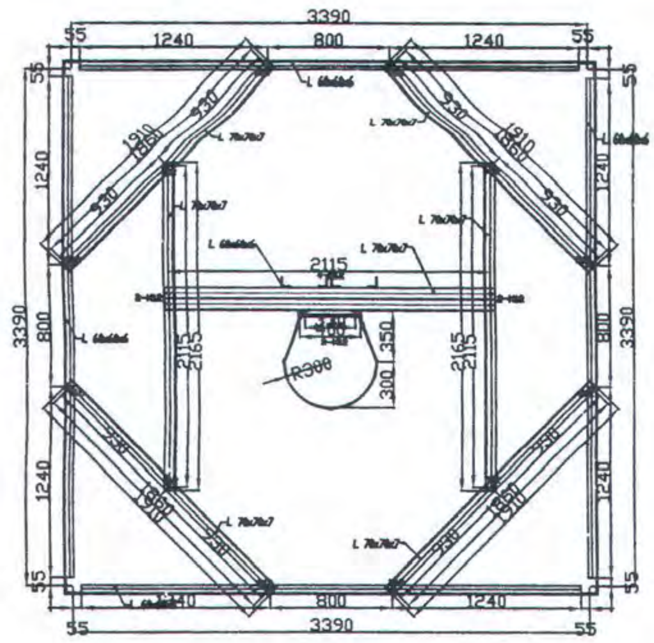
	Drawing No	Index
SCALA 1:25	13	0



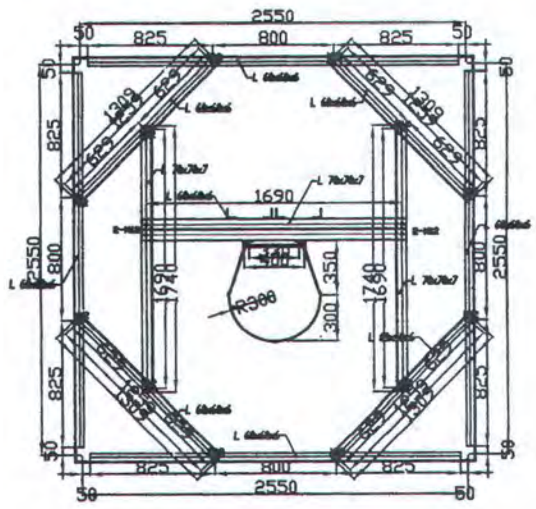
PLATFORM J
Elv. 56.000



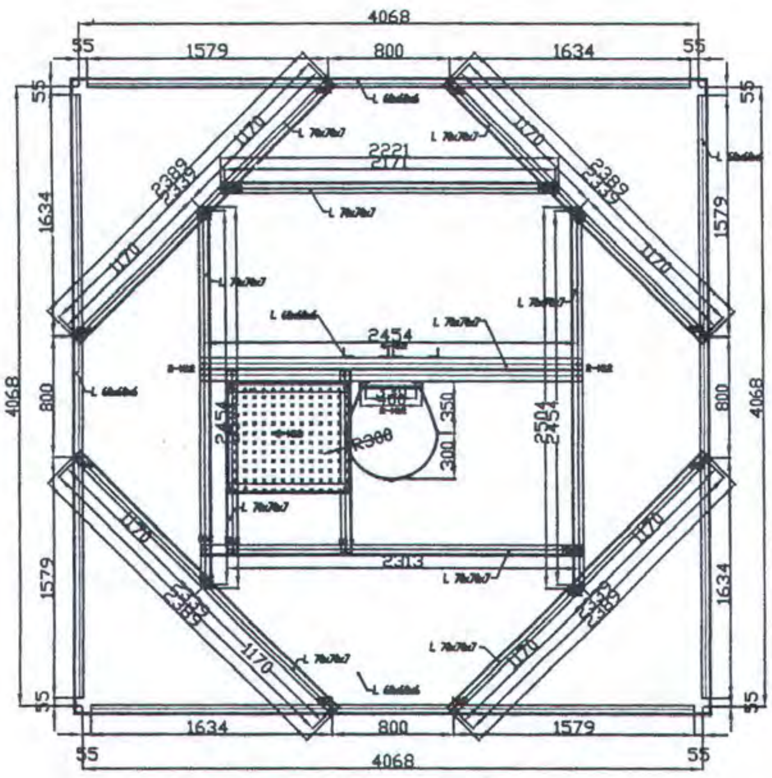
PLATFORM L
Elv. 64.000



PLATFORM I
Elv. 54.000



PLATFORM K
Elv. 62.000



PLATFORM H
Elv. 47.500

	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
S U R A B A Y A

	Name	Date	Sign
Designed			
Drawn			
Checked			
Approved			

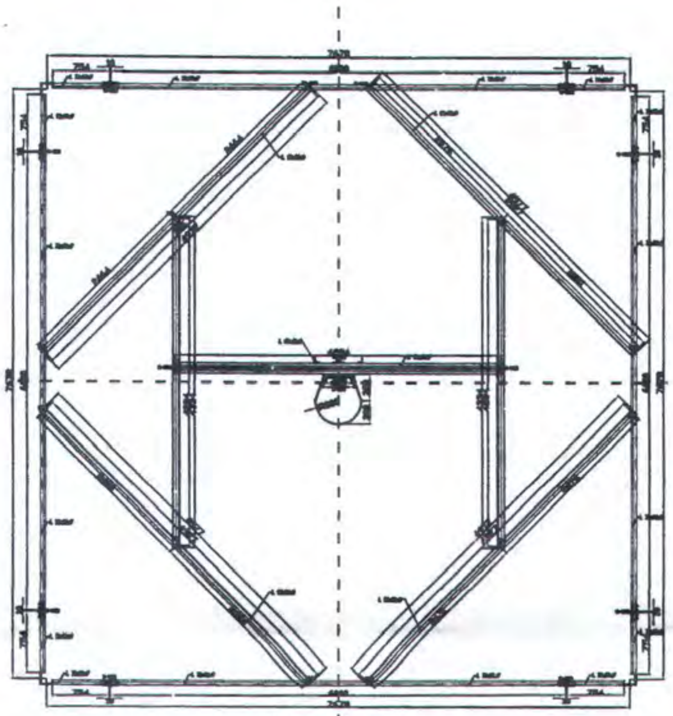
Title: TOWER SST-80 M

Sub Title: PLATFORM H-S

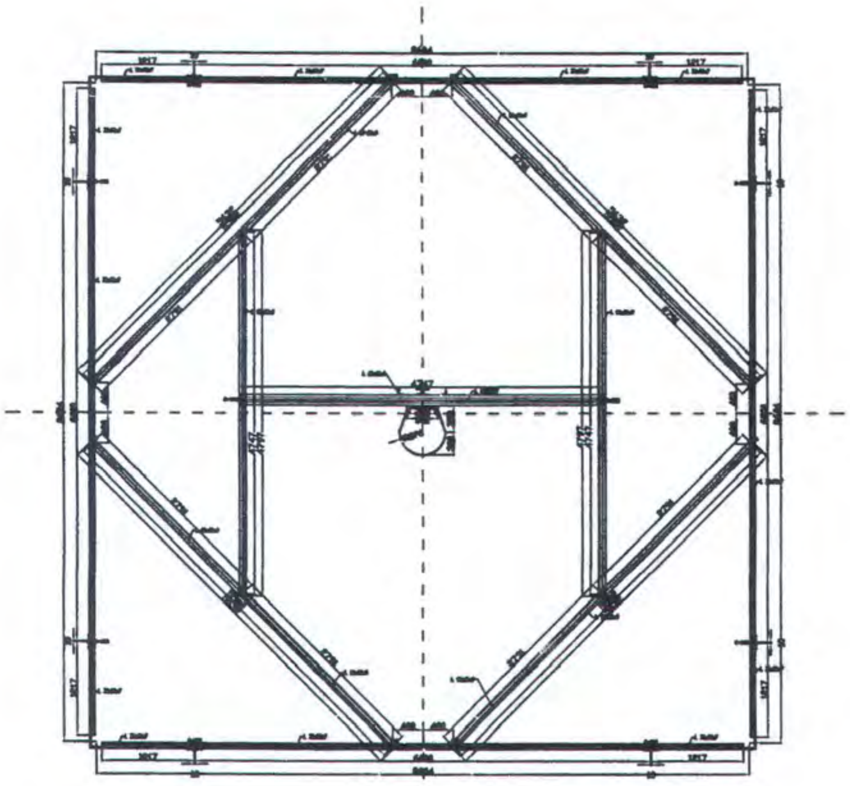
SCALA 1:50

Drawing No: 13

Index: 0



PLATFORM
Elv. 12.000



PLATFORM A
Elv. 3.000

	Name	ID	Sign
Checked by	Ir.R SUWARDOYO		
Designed by	TRI WINARTO	3102.109.515	

JURUSAN TEKNIK SIPIL ITS
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
S U R A B A Y A

	Name	Date	Sign
Designed			
Drawn			
Checked			
Approved			

Title: TOWER SST-80 M

Sub Title: PLATFORM A

SCALA 1:50

Drawing No	Index
9	0